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RADIATION DATA AND REPORTS

Volume 13, Number 7, July 1972

Radiation Data and Reports, a monthly publication of the Environmental Protection Agency, presents data and reports provided by Federal, State, and foreign governmental agencies, and other cooperating organizations. Pertinent original data and interpretive manuscripts are invited from investigators.

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. This responsibility was delegated to the Bureau of Radiological Health, Public Health Service. Pursuant to the Reorganization Plan No. 3 of 1970, effective December 2, 1970, this responsibility was transferred to the Radiation Office of the Environmental Protection Agency which was established by this reorganization.

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U.S. ENVIRONMENTAL PROTECTION AGENCY
William D. Ruckelshaus, Administrator

Reports

Radiation Exposure to Staff Cardiologist vs. Senior Resident Cardiologist and Patients During Cardiac Catheterization

Stanley J. Malsky, Ph.D.,[1] Jacob Haft, M.D.,[2] David Hayt, M.D.,[3] Lawrence Gould, M.D.,[4] Charles Blatt, M.D.,[5] Donald F. Simon, M.S.[6] and Bernard Roswit, M.D.[7]

A study was conducted to compare the radiation exposure received by a senior resident cardiologist to that of the staff cardiologist when performing a full cardiac procedure. In addition, patient exposure values were obtained. The staff cardiologist was found to receive approximately 50–60 mR/procedure in the chest region and the senior resident received approximately 61 to 73 mR. The exposure to patients as calculated from tabletop measurements varied from 24 to 73 R.

The role of the medical physicist encompasses many responsibilities in the hospital setting. In diagnostic radiology, radiation therapy, and nuclear medicine, the assignments may include clinical, consultation, teaching, research, health physics and radiation protection studies. For diagnostic radiology, the responsibilities in part include technical assistance in the evaluation of diagnostic procedures in terms of possible dose reduction to patients and personnel, and evaluation of the performance of new diagnostic equipment. It was within the framework of the above criteria that this study was undertaken.

Background

A recent study by the Division of Medical Radiation Exposure, Bureau of Radiological Health (*1*) reported that between the years 1964 (*2*) and 1970, the use of medical x rays has increased over 25 percent. During this same period of time, complicated, time-consuming, new special procedures have increased patient exposure time in the radiological setting (*3–5*). One of these special diagnostic radiographic procedures, cardiac catheterization, may require from 2 to 4 hours and may incur considerable patient exposure time. These time factors therefore lead to the conclusion that both patient and support personnel could receive considerable doses of radiation.

In a preliminary paper (*6*), a dosimetry study was undertaken of the cardiac catheterization team for a number of full procedures; the present study is a continuation of the preliminary work.

Purpose of the study

This study attempts to compare the radiation exposure received by the senior resident cardiologist to that of the staff cardiologist when each performed a full cardiac procedure. Naturally, the level of difficulty in a particular case can nullify a particular comparison. The data obtained, therefore, are an average of total, live fluoroscopy time. A second part of this study was to obtain patient exposure values (R) and area exposed (cm^2) in terms of R–cm^2.

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[5] Chief, Radiology Service, Fordham Hospital, Bronx, N.Y.

[6] Chief physicist, Misericordia Hospital, Bronx, N.Y.

[7] Chief, Radiotherapy Service, Veterans Hospital, Bronx, N.Y.

Dosimetry techniques

The dosimetry systems consisted of:

1. commercial, conventional, clip-on and wrist film badges, and
2. thermoluminescent (TL) lithium fluoride (LiF) wafers, 12.7 mm in diameter.

Individual film badges were issued only once to the medical staff per examination and then returned to the vendor for development and results. The film badges were worn by the cardiologist at the following locations:

1. collar level, outside lead apron.
2. chest level, outside lead apron.
3. chest level, inside lead apron.
4. wrist of hand, and
5. back, waist level, outside lead apron.

Thermoluminescent dosimetry techniques have been described in a number of papers (*7,8*) and texts (*9–11*) and will not be covered in this article in detail, other than to indicate that annealing, screening, quality control techniques were employed for the dosimeters prior to use. The TL discs were used in pairs: placed into a plastic bag, sealed, and then mounted on the underside of ordinary adhesive bandages (figure 1). These adhesive bandage dosimetry packages were then positioned on the following anatomical sites, adjacent (when applicable) to where film badges were stationed:

1. over the left eye,
2. over the right eye,
3. collar, outside lead apron,
4. chest, outside lead apron,
5. chest, inside lead apron,
6. wrist,
7. back, waist level, outside lead apron,
8. gonadal area, inside lead apron, and
9. gonadal area, outside lead apron.

Patient exposure (R–cm^2)

It is possible to obtain an approximate patient total exposure value by employing a reconstruction of the clinical study using a phantom and the various physical factors (kV, mAs, source-to-patient distance, and filtration). In dynamic studies, the ideal setting would be to obtain dosimetry information of the performance of the actual procedure. In an attempt to determine patient exposure over various portal sizes, an R–cm^2 unit was installed directly in front of the adjustable x-ray collimator. This unit serves to indicate that a patient has received a certain area dose which can be compared to that received by another patient: it is not an absolute value, but certain data and inferences can be obtained using this unit.

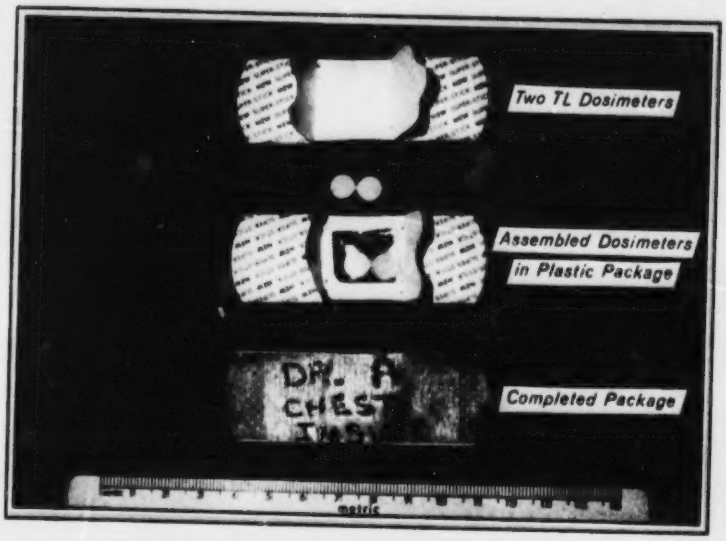

Figure. 1. Thermoluminescent dosimeter package

A commercial model of this system is the Diamentor.[a] It consists of a parallel plate ionization chamber, a preamplifier, and a control unit which has a digital readout and printer. The chamber is mounted directly in front of the adjustable diaphragm so that the entire x-ray beam always passes through it. The Diamentor is calibrated so that each step recorded is equivalent to an area exposure of 1 or 10 R–cm^2. Consider a skin dose with fields 8 × 8 cm (64 cm^2) and of 16 × 16 cm (256 cm^2); in the latter case approximately four times the radiation has been delivered. The chamber therefore has value in terms of:

1. an approximation of patient area exposure, and
2. in a residency training program, it could serve as a measure of residency ability, and finally
3. as a health physics guide in the cardiology department.

The physical characteristics of the x-ray system as employed in this study are:

1. full-wave rectification, single phase,
2. voltage-125 kV (65–100 kVp actual), current-300 mA.,
3. live time: 5 to 20 minutes (fluoroscopy); cine time: up to 4 minutes; total procedural time: 1–4 hours,
4. filter—2.5 mm aluminum added, plus 0.5 mm aluminum inherent plus 0.4 mm aluminum equivalent for the parallel plate ionization chamber (Diamentor). Total filtration: 3.4 mm aluminum equivalent,
5. tabletop measurement: 3.0 R/min. at 100 kVp at a source to table distance of 38 cm: 10 × 10 cm field,
6. image intensifier face—22 cm diameter,
7. table top field size: 60–180 cm^2, and
8. automatic brightness control.

The above factors contain some changes from the original study (*6*). Basically, the total filtration has increased slightly due to the addition of the ionization chamber on the adjustable collimator. The field size at the fluoroscope screen has generally been reduced from a range of 180–300 cm^2 to a range of 150–250 cm^2.

Procedure

The Judkens technique for coronary arteriography was employed in all cases. The catheterization team consists of three physicians, a nurse and a technician. The approximate location of each member is shown in figure 2. All personnel wear 0.5-mm lead rubber aprons. There is no lead overleaf or flexible lead rubber drape about the radiographic tube. The physician performing the procedure does not wear lead rubber gloves. The radiation field intensities (mR/h) were measured using suitable ionization chamber rate meters.

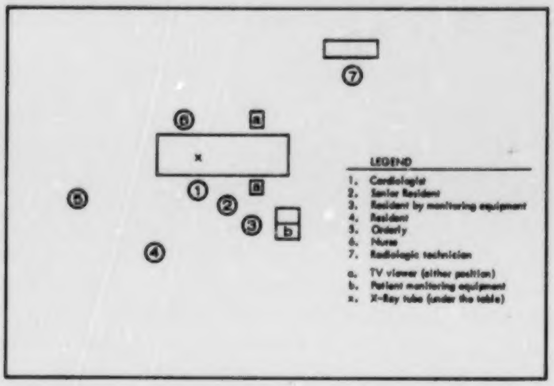
⑦
⑥
a
x
①
②
③
④
⑤
b
LEGEND
1. Cardiologist
2. Senior Resident
3. Resident by monitoring equipment
4. Resident
5. Orderly
6. Nurse
7. Radiologic technician
a. TV viewer (either position)
b. Patient monitoring equipment
x. X-Ray tube (under the table)

Figure 2. Approximate location of personnel during a cardiac procedure

As far as possible during fluoroscopy, the direct beam was limited to the cardiac silhouette. The dimensions of the field varied with the heart size. The live time varied with:

1. the difficulty ascribed to each patient, and
2. whether the senior cardiac resident or the senior medical member performed the study.

Results

Of the 12 patients (adult males) receiving a full cardiac catheterization procedure, the exposure as calculated from tabletop measurements varied from 24 to 73 R. The portal size at the posterior of the patient ranged from 60 cm^2 to 180 cm^2. The corresponding R–cm^2 readings were in the range of 1,420 to 4,700 R–cm^2 with an average of 2,100 R–cm^2.

Exposure data for medical personnel performing the studies are contained in table 1.

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[a] Nuclear Associates, Westbury, Long Island, N.Y.

Table 1. Summary of dosimetry readings for full cardiac procedure

Location of dosimeters[a]	Staff cardiologist		Senior resident cardiologist	
	Range (mR)	Mean (mR)	Range (mR)	Mean (mR)
Eye area (TL)	16–20	18	16–44	30
Collar (F)	17–55	36	20–68	44
Collar (TL)	19–29	24	24–42	33
Chest (O, F)	278–700	489	290–850	570
Chest (O, TL)	330–700	515	409–720	564
Chest (I, F)	30–70	50	41–81	61
Chest (I, TL)	40–80	60	48–99	73
Wrist (F)	102–161	131	100–170	135
Wrist (TL)	119–177	143	124–185	154
Back (F)	<10–19	10	<10–18	10
Back (TL)	<10–20	10	<10–24	10
Gonads (I, F)	<10	<10	<10	<10
Gonads (I, TL)	<10	<10	<10	<10

[a] F, film dosimetry; TL, thermoluminescent dosimetry; O, outside lead gown; I, inside lead gown.

As can be noted from the data, the senior staff receives on the average, approximately 1/3 to 1/2 of the maximum weekly permissible dose to the trunk of the body if a single full procedure is performed without assistance. A senior cardiac resident receives approximately 25 percent more to the same body part as a result of his general limited experience.

Discussion

This study attempted to determine medical staff (senior staff and senior residents) exposure to various anatomical sites while performing a full cardiac catheterization, and an estimate of patient area exposure.

Personnel exposure was measured by the techniques of film badges and thermoluminescent dosimetry. Patient exposure was determined using live-time data, R/mm tabletop measurements, and R–cm² for area exposure.

While it is understood that the R–cm² data are not absolute values, and that integral dose in terms of kilogram-rad or millijoules for the measurement of radiant energy may be desirable, the mode of recording patient area exposure in the R–cm² unit does serve a purpose. In a teaching hospital, the R–cm² unit can serve as a measure (at first approximation) of area dose received by patients during procedures conducted by various residents or senior staff. It may also serve with suitable mathematical modeling as a means of comparison of integral doses.

It should be noted that it is highly desirable that the consulting services of a radiologist and a medical physicist be available, and they should be considered as an integral advisory part of that service.

Future projections

The following areas are being explored:

1. comparison studies between hospitals are in progress,
2. patient (male, female and children); gonadal information is essential and is being obtained,
3. investigation of the use of image storage systems as a mode of reducing both personnel and patient exposure. One such system, developed by Cameron et al.[a] and viewed using phantoms, shows promise and possible application in fluoroscopic examination, and
4. further studies with the R–cm² unit in terms of resident training and health physics are continuing and an attempt will be made to relate these values to integral dose of the patient.

Acknowledgements

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[a] Personal communication from J. R. Cameron.

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Data

SECTION I. MILK AND FOOD

Milk Surveillance, March 1972

Although milk is only one of the sources of dietary intake of environmental radioactivity, it is the food item that is most useful as an indicator of the general population's intake of radionuclide contaminants resulting from environmental releases. Fresh milk is consumed by a large segment of the population and contains several of the biologically important radionuclides that may be released to the environment from nuclear activities. In addition, milk is produced and consumed on a regular basis, is convenient to handle and analyze, and samples representative of general population consumption can be readily obtained. Therefore, milk sampling networks have been found to be an effective mechanism for obtaining information on current radionuclide concentrations and long-term trends. From such information, public health agencies can determine the need for further investigation or corrective public health action.

The Pasteurized Milk Network (PMN) sponsored by the Office of Radiation Programs, Environmental Protection Agency, and the Office of Food Sanitation, Food and Drug Administration, Public Health Service, consists of 63 sampling stations: 61 located in the United States, one in Puerto Rico, and one in the Canal Zone. Many of the State health departments also conduct local milk surveillance programs which provide more comprehensive coverage within the individual State. Data from 15 of these State networks are reported routinely in *Radiation Data and Reports*. Additional networks for the routine surveillance of radioactivity in milk in the Western Hemisphere and their sponsoring organizations are:

Pan American Milk Sampling Program (Pan American Health Organization and U.S. Environmental Protection Agency)—5 sampling stations

Canadian Milk Network (Radiation Protection Division, Canadian Department of National Health and Welfare)—16 sampling stations.

The sampling locations that make up the networks presently reporting in *Radiation Data and Reports* are shown in figure 1. Based on the similar purpose for these sampling activities, the present format integrates the complementary data that are routinely obtained by these several milk networks.

Radionuclide and element coverage

Considerable experience has established that relatively few of the many radionuclides that are formed as a result of nuclear fission become incorporated in milk (*1*). Most of the possible radiocontaminants are eliminated by the selective metabolism of the cow, which restricts gastrointestinal uptake and secretion into the milk. The five fission-product radionuclides which commonly occur in milk are strontium-89, strontium-90, iodine-131, cesium-137, and barium-140. A sixth radionuclide, potassium-40, occurs naturally in 0.0118 percent (*2*) abundance of the element potassium, resulting in a specific activity for potassium-40 of 830 pCi/g total potassium.

Two stable elements which are found in milk, calcium and potassium, have been used as a means for assessing the biological behavior of

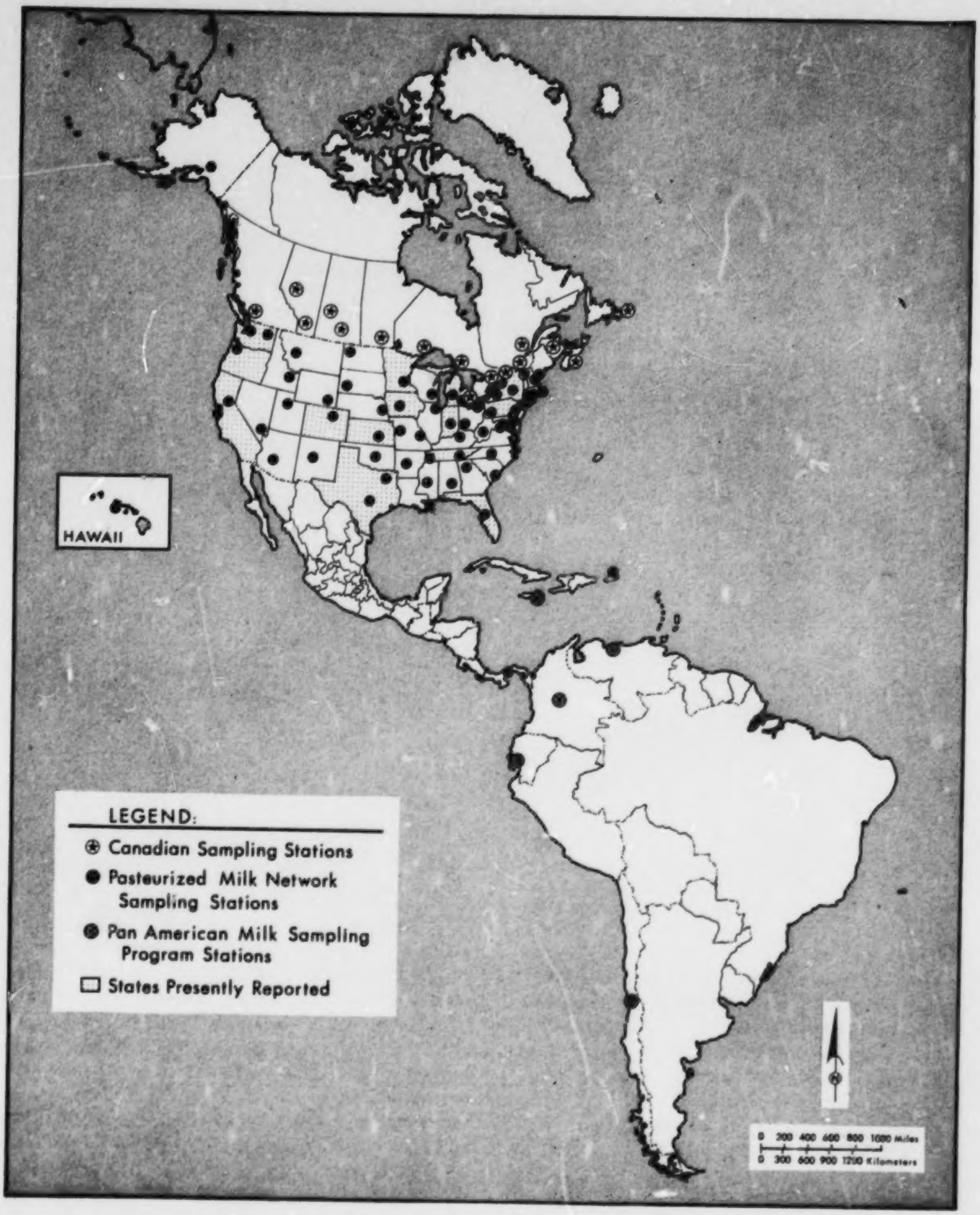
HAWAII
LEGEND:
⊛ Canadian Sampling Stations
● Pasteurized Milk Network Sampling Stations
● Pan American Milk Sampling Program Stations
☐ States Presently Reported
0 200 400 600 800 1000 Miles
0 300 600 900 1200 Kilometers

Figure 1. Milk sampling networks in the Western Hemisphere

metabolically similar radionuclides (radiostrontium and radiocesium, respectively). The contents of both calcium and potassium in milk have been measured extensively and are relatively constant. Appropriate values and their variations, expressed in terms of 2 standard deviations (2σ), for these elements are 1.16 ± 0.08 g/liter for calcium and 1.51 ± 0.21 g/liter for potassium. These figures are averages of data from the PMN for May 1963–March 1966 (*3*) and were determined for use in general radiological health calculations or discussions.

Accuracy of data from various milk networks

In order to combine data from the international, national, and State networks considered in this report, it was first necessary to determine the accuracy with which each laboratory is making its determinations and the agreement of the measurements among the laboratories. The Analytical Quality Control Service of the Office of Radiation Programs conducts periodic studies to assess the accuracy of determinations of radionuclides in milk performed by interested radiochemical laboratories. The generalized procedure for making such a study has been outlined previously (*4*).

The most recent study was conducted during July 1971 with 37 laboratories participating in an experiment on a milk sample containing known concentrations of iodine-131, cesium-137, strontium-89, and strontium-90 (*5*). Of the 17 laboratories producing data for the networks reporting in *Radiation Data and Reports*, 14 participated in the experiment.

The accuracy results of this experiment for these 14 laboratories are shown in table 1. Considerable improvement has been made in the accuracy of the analyses of all radionuclides compared to the results of previous studies. Some improvement is still needed in the technique for determining the strontium-90 results. These possible differences should be kept in mind when considering the integration of data from the various networks.

Development of a common reporting basis

Since the various networks collect and analyze samples differently, a complete understanding of several parameters is useful for interpreting the data. Therefore, the various milk surveillance networks that report regularly were surveyed for information on analytical methods, sampling and analysis frequencies, and estimated analytical errors associated with the data.

In general, radiostrontium is collected by an ion-exchange technique and determined by beta-particle counting in low-background detectors, and the gamma-ray emitters (potassium-40, iodine-131, cesium-137, and barium-140) are determined by gamma-ray spectroscopy of whole milk. Each laboratory has its own modifications and refinements of these basic methodologies. The methods used by each of the networks have been referenced in earlier reports appearing in *Radiological Health Data and Reports.*

A previous article (*6*) summarized the criteria used by the State networks in setting up their milk sampling activities and their sample collection procedures as determined during a 1965 survey. This reference and an earlier data

Table 1. Distribution of mean results, quality control experiment

Isotope and known concentration	Number of laboratories in each category			
	Acceptable[a]	Warning level[b]	Unacceptable[c]	Total
Iodine-131 (69 pCi/liter)	13 (100%)	0	0	13
Cesium-137 (52 pCi/liter)	12 (92%)	1 (8%)	0	13
Strontium-89 (31 pCi/liter)	9 (90%)	1 (10%)	0	10
Strontium-90 (41.6 pCi/liter)	9 (69%)	1 (8%)	3 (23%)	13

[a] Measured concentration equal to or within 2σ of the known concentration.
[b] Measured concentration outside 2σ and equal to or within 3σ of the known concentration.
[c] Measured concentration outside 3σ of the known concentration.

article for the particular network of interest may be consulted should events require a more definitive analysis of milk production and milk consumption coverage afforded by a specific network.

Many networks collect and analyze samples on a monthly basis. Some collect samples more frequently but composite the several samples for one analysis, while others carry out their analyses more often than once a month. Many networks are analyzing composite samples on a quarterly basis for certain nuclides. The frequency of collection and analysis varies not only among the networks but also at different stations within some of the networks. In addition, the frequency of collection and analysis is a function of current environmental levels. The number of samples analyzed at a particular sampling station under current conditions is reflected in the data presentation. Current levels for strontium-90 and cesium-137 are relatively stable over short periods of time, and sampling frequency is not critical. For the short-lived radionuclides, particularly iodine-131, the frequency of analysis is critical and is generally increased at the first measurement or recognition of a new influx of this radionuclide.

The data in table 2 shows whether raw or pasteurized milk was collected. An analysis (*7*) of raw and pasteurized milk samples collected during January 1964 to June 1966 indicated that for relatively similar milkshed or sampling areas, the differences in concentration of radionuclides in raw and pasteurized milk are not statistically significant (*7*). Particular attention was paid to strontium-90 and cesium-137 in that analysis.

Practical reporting levels were developed by the participating networks, most often based on 2-standard-deviation counting errors or 2-standard-deviation total analytical errors from replicate analyses (*3*). The practical reporting level reflects analytical factors other than statistical radioactivity counting variations and will be used as a practical basis for reporting data.

The following practical reporting levels have been selected for use by all networks whose practical reporting levels were given as equal to or less than the given value.

Radionuclide	Practical reporting level (pCi/liter)
Strontium-89	5
Strontium-90	2
Iodine-131	10
Cesium-137	10
Barium-140	10

Some of the networks gave practical reporting levels greater than those above. In these cases, the larger value is used so that only data considered by the network as meaningful will be presented. The practical reporting levels apply to the handling of individual sample determinations. The treatment of measurements equal to or below these practical reporting levels for calculation purposes, particularly in calculating monthly averages, is discussed in the data presentation.

Analytical error or precision expressed as pCi/liter or percent in a given concentration range has also been reported by the networks (*3*). The precision errors reported for each of the radionuclides fall in the following ranges:

Radionuclide	Analytical errors of precision (2 standard deviations)
Strontium-89	1–5 pCi/liter for levels <50 pCi/liter; 5–10% for levels $\geqq 50$ pCi/liter;
Strontium-90	1–2 pCi/liter for levels <20 pCi/liter; 4–10% for levels $\geqq 20$ pCi/liter;
Iodine-131	4–10 pCi/liter for levels <100 pCi/liter; 4–10% for levels $\geqq 100$ pCi/liter.
Cesium-137	
Barium-140	

For iodine-131, cesium-137, and barium-140, there is one exception for these precision error ranges: 25 pCi/liter at levels <100 pCi/liter for Colorado. This is reflected in the practical reporting level for the Colorado milk network.

Federal Radiation Council guidance applicable to milk surveillance

In order to place the U.S. data on radioactivity in milk presented in *Radiation Data and Reports* in perspective, a summary of the guidance provided by the Federal Radiation Council

Table 2. Concentrations of radionuclides in milk for March 1972 and 12-month period, April 1971 through March 1972

Sampling location		Type of sample[a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average[b]	12-month average	Monthly average[b]	12-month average
UNITED STATES:						
Ala:	Montgomery[c]	P	NA	7	19	10
Alaska:	Palmer[c]	P	4	5	7 (2)	12
Ariz:	Phoenix[c]	P	NA	0	0 (2)	0
Ark:	Little Rock[c]	P	NA	12	7 (2)	15
Calif:	Sacramento[c]	P	NA	1	0 (2)	0
	San Francisco[c]	P	NA	4	0	0
	Del Norte	P	12	13	0	12
	Fresno	P	2	2	0	5
	Humboldt	P	4	3	0	6
	Los Angeles	P	0	2	0	4
	Mendocino	P	NA	7	0	9
	Sacramento	P	2	3	0	5
	San Diego	P	0	1	0	4
	Santa Clara	P	0	2	0	7
	Shasta	P	2	3	11	7
	Sonoma	P	3	8	7	7
Colo:	Denver[c]	P	NA	5	6 (2)	9
	East	R	(d)		<0 (2)	<0
	Northeast	R	(d)		NS	<1
	Northwest	R	(d)		<0	<0
	South Central	R	(d)		NS	
	Southeast	R	(d)		<0	<0
	Southwest	R	(d)		<0	<2
	West	R	(d)		<0	<0
Conn:	Hartford[c]	P	NA	7	14 (2)	9
	Central	P	7	7	15	15
Del:	Wilmington[c]	P	NA	8	0	4
D.C:	Washington[c]	P	NA	8	11	9
Fla:	Tampa[c]	P	4	5	37 (4)	41
	Central	R	5	6	37	44
	North	R	NA	10	17	24
	Northeast	R	7	7	17	35
	Southeast	R	8	6	54	54
	Tampa Bay area	R	4	6	36	40
	West	R	8	11	16	20
Ga:	Atlanta[c]	P	NA	10	12 (2)	16
Hawaii:	Honolulu[c]	P	3	3	0	2
Idaho:	Idaho Falls[c]	P	5	5	0 (2)	1
Ill:	Chicago[c]	P	7	7	17 (2)	10
Ind:	Indianapolis[c]	P	NA	7	8 (2)	5
	Central	P	8	7	15	13
	Northeast	P	6	6	15	15
	Northwest	P	8	8	15	15
	Southeast	P	7	8	15	15
	Southwest	P	8	9	10	15
Iowa:	Des Moines[c]	P	NA	6	0 (2)	2
	Des Moines	P	6	6	9 (3)	11
	Iowa City	P	6	7	13	10
	Little Cedar	P	8	7	13	13
	Spencer	P	6	6	11	13
Kans:	Wichita[c]	P	NA	8	0 (2)	2
	Coffeyville	P	8	8	16	14
	Dodge City	P	4	6	7	9
	Falls City, Nebr.	P	11	4	6	7
	Hays	P	8	10	14	9
	Kansas City	P	9	9	13	12
	Topeka	P	8	8	17	10
	Wichita	P	8	9	4	12
Ky:	Louisville[c]	P	NA	8	14 (2)	8
La:	New Orleans[c]	P	15	14	11 (2)	16
Maine:	Portland[c]	P	NA	8	18 (2)	20
Md:	Baltimore[c]	P	NA	8	0	5
Mass:	Boston[c]	P	7	8	11 (2)	11
Mich:	Detroit[c]	P	NA	7	13 (2)	10
	Grand Rapids[c]	P	NA	9	13 (2)	10
	Bay City	P	0	6	18	15
	Charlevoix	P	NS	10	NS	15
	Detroit	P	0	6	8 (2)	11
	Grand Rapids	P	6	6	0	9
	Lansing	P	4	7	16 (2)	16
	Marquette	P	4	8	24 (2)	24
	Monroe	P	3	4	8 (2)	4
	South Haven	P	2	6	16 (5)	10
Minn:	Minneapolis[c]	P	NA	8	18 (2)	17
	Bemidji	P	8	8	22	20
	Duluth	P	14	16	28	29
	Fergus Falls	P	6	8	16	17
	Little Falls	P	16	17	18	20
	Mankato	P	6	7	18	12
	Minneapolis	P	10	13	17	17

See footnotes at end of table.

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Table 2. Concentration of radionuclides in milk for March 1972 and 12-month period, April 1971 through March 1972—continued

Sampling location		Type of sample[a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average[b]	12-month average	Monthly average[b]	12-month average
UNITED STATES:						
Minn:	Rochester	P	8	16	0	14
	Worthington	P	7	6	14	12
Miss:	Jackson[c]	P	NA	13	8 (2)	10
Mo:	Kansas City[c]	P	NA	8	6 (2)	7
	St. Louis[c]	P	NA	5	9 (2)	6
Mont:	Helena[c]	P	NA	6	6 (2)	9
Nebr:	Omaha[c]	P	NA	7	6 (2)	4
Nev:	Las Vegas[c]	P	NA	2	0 (2)	1
N.H:	Manchester[c]	P	NA	8	21 (2)	19
N.J:	Trenton[c]	P	NA	8	15 (2)	9
N. Mex:	Albuquerque[c]	P	NA	2	0 (2)	0
N.Y:	Buffalo[c]	P	6	7	8 (2)	7
	New York City[c]	P	NA	8	10 (2)	11
	Syracuse[c]	P	NA	7	8 (2)	8
	Albany	P	10	6	[d]0 (6)	[d]0
	Buffalo	P	8	0	[d]14	[d]0
	Massena	P	8	6	[d]0 (2)	[d]0
	New York City	P	7	7	[d]0	[d]0
	Syracuse	P	NS		NS	
N.C:	Charlotte[c]	P	NA	10	18	12
N. Dak:	Minot[c]	P	NA	9	20 (2)	14
Ohio:	Cincinnati[c]	P	NA	6	7 (2)	1
	Cleveland[c]	P	NA	7	6 (2)	7
Okla:	Oklahoma City[c]	P	NA	6	8 (2)	8
Oreg:	Portland[c]	P	4	5	0 (2)	6
	Baker	P	NA		NA	
	Coos Bay	P	NA		NA	
	Eugene	P	NA		NA	
	Medford	P	NA		NA	
	Portland composite	P	NA		NA	
	Portland local	P	NA		NA	
	Redmond	P	NA		NA	
	Tillamook	P	NA		NA	
Pa:	Philadelphia[c]	P	NA	8	0	5
	Pittsburgh[c]	P	NA	10	16	6
	Dauphin	P	5	7	18	11
	Erie	P	0	8	20	15
	Philadelphia	P	0	5	12	15
	Pittsburgh	P	8	7	21	14
R.I:	Providence[c]	P	NA	8	17 (2)	12
S.C:	Charleston[c]	P	10	9	14 (2)	15
S. Dak:	Rapid City[c]	P	NA	6	0 (2)	7
Tenn:	Chattanooga[c]	P	NA	8	8 (2)	11
	Memphis[c]	P	NA	7	0 (2)	7
	Chattanooga	P	12	10	15 (2)	14
	Clinton	R	10	9	19 (2)	14
	Fayetteville	R	14	10	17 (2)	7
	Kingston	R	14	9	16 (2)	10
	Knoxville	P	10	8	18 (2)	10
	Lawrenceburg	R	11	8	24 (2)	7
	Nashville	P	9	8	14 (2)	7
	Pulaski	R	7	8	7 (2)	4
Tex:	Austin[c]	P	NA	2	0 (2)	0
	Dallas[c]	P	NA	6	0 (2)	8
	Amarillo	R	6	4	0	0
	Corpus Christi	R	NS	5	NS	0
	El Paso	R	NS	3	NS	0
	Fort Worth	R	NS	4	NS	0
	Harlingen	R	3	4	0	0
	Houston	R	NS	6	NS	8
	Lubbock	R	NS	4	NS	0
	Midland	R	NS	3	NS	0
	San Antonio	R	4	5	0	0
	Texarkana	R	11	11	0	0
	Tyler	R	NS	10	NS	10
	Wichita Falls	R	NS	7	NS	5
Utah:	Salt Lake City[c]	P	6	5	16 (2)	11
Vt:	Burlington[c]	P	NA	6	16 (2)	11
Va:	Norfolk[c]	P	NA	8	0	5
Wash:	Seattle[c]	P	NA	5	0 (2)	8
	Spokane[c]	P	NA	6	16 (2)	7
	Benton County	R	0	1	0	0
	Franklin County	R	NS	1	NS	6
	Sandpoint, Idaho	R	14	12	18	22
	Skagit County	R	5	8	0	9
W. Va:	Charleston[c]	P	NA	8	0	6
Wisc:	Milwaukee[c]	P	NA	6	9 (2)	6
Wyo:	Laramie[c]	P	NA	4	0 (2)	2

See footnotes at end of table.

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Table 2. Concentration of radionuclides in milk for March 1972 and 12-month period, April 1971 through March 1972—continued

Sampling location		Type of sample[a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average[b]	12-month average	Monthly average[b]	12-month average
CANADA:						
Alberta:	Calgary	P	7	7	22	20
	Edmonton	P	7	7	21	24
British Columbia:	Vancouver	P	6	9	23	26
Manitoba:	Winnipeg	P	8	8	23	24
New Brunswick:	Fredericton	P	11	12	21	22
Newfoundland:	St. John's	P	14	18	18	34
Nova Scotia:	Halifax	P	8	11	19	25
Ontario:	Ottawa	P	5	6	13	14
	Sault Ste. Marie	P	11	13	26	32
	Thunder Bay	P	10	11	22	25
	Toronto	P	4	5	10	13
	Windsor	P	3	5	8	10
Quebec:	Montreal	P	7	7	13	17
	Quebec	P	9	10	27	29
Saskatchewan:	Regina	P	7	7	23	17
	Saskatoon	P	7	9	20	19
CENTRAL AND SOUTH AMERICA:						
Canal Zone:	Cristobal[c]	P	NA	0	0	4
Chile:	Santiago	P	0	0	0	2
Colombia:	Bogota	P	0	1	0	0
Ecuador:	Guayaquil	P	0	0	0	0
Jamaica:	Mandeville	P	NS	4	NS	68
Puerto Rico:	San Juan[c]	P	NA	4	0	10
Venezuela:	Caracas	P	0	0	0	0
PMN network average[f]			6	7	8	8

[a] P, pasteurized milk.
R, raw milk.

[b] When an individual sampling result was equal to or less than the practical reporting level, a value of "0" was used for averaging. Monthly averages less than the practical reporting level reflect the fact that some but not all of the individual samples making up the average contained levels greater than the practical reporting level. When more than one analysis was made in a monthly period, the number of samples in the monthly average is given in parentheses.

[c] Pasteurized Milk Network station. All other sampling locations are part of the State or National network.

[d] Radionuclide analysis not routinely performed.

[e] The practical reporting levels for these networks differ from the general ones given in the text. Sampling results for the networks were equal to or less than the following practical reporting levels:

Iodine-131:	Colorado—25 pCi/liter	Cesium-137:	Colorado—25 pCi/liter	Strontium-90:	New York—3 pCi/liter
	Michigan—14 pCi/liter		New York—20 pCi/liter		
	Oregon—15 pCi/liter		Oregon—15 pCi/liter		

[f] This entry gives the average radionuclides concentrations for the Pasteurized Milk Network stations denoted by footnote [c].
NA, no analysis.
NS, no sample collected.

for specific environmental conditions was presented in the December 1970 issue of *Radiological Health Data and Reports.*

Data reporting format

Table 2 presents the integrated results of the international, national, and State networks discussed earlier. Column 1 lists all the stations which are routinely reported to *Radiation Data and Reports.* The relationship between the PMN stations and the State stations is shown in figure 2. The first column under each of the reported radionuclides gives the monthly average for the station and the number of samples analyzed in that month in parentheses. When an individual sampling result is equal to or below the practical reporting level for the radionuclide, a value of zero is used for averaging. Monthly averages are calculated using the above convention. Averages which are equal to or less than the practical reporting levels reflect the presence of radioactivity in some of the individual samples greater than the practical reporting level.

The second column under each of the radionuclides reported gives the 12-month average

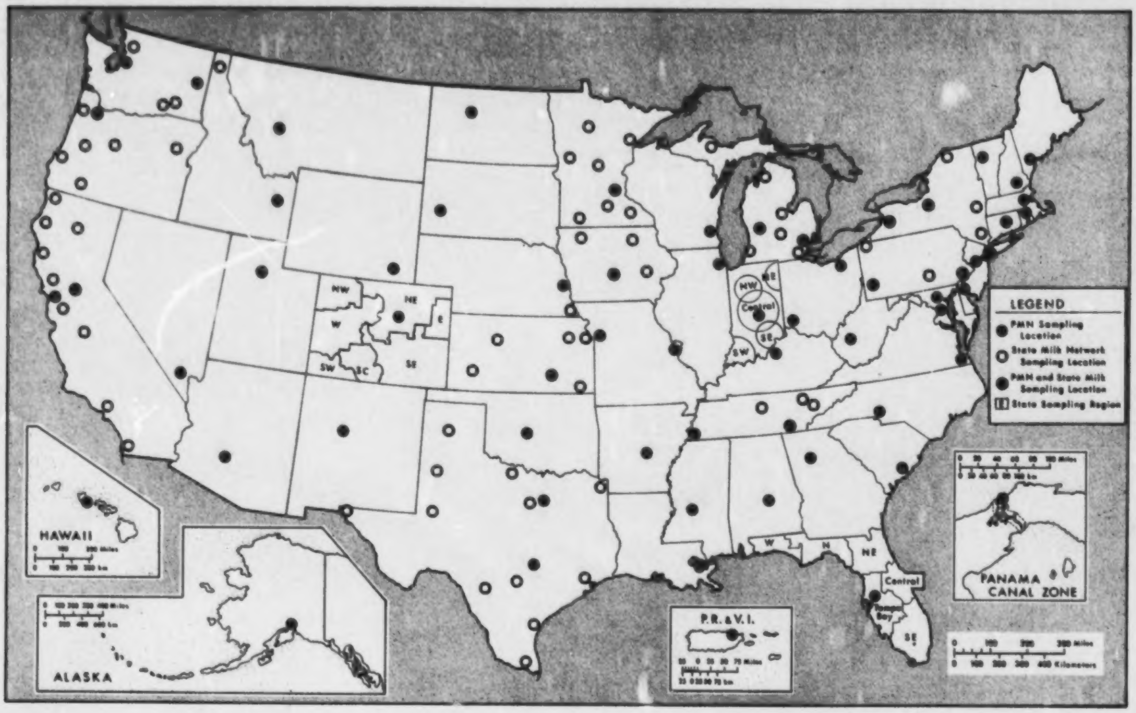
LEGEND
PMN Sampling Location
State Milk Network Sampling Location
PMN and State Milk Sampling Location
State Sampling Region
NW
NE
W
E
SW
SC
SE
Central
N
HAWAII
ALASKA
P.R.&V.I.
PANAMA CANAL ZONE

Figure 2. State and PMN milk sampling stations in the United States

for the station as calculated from the preceding 12 monthly averages, giving each monthly average equal weight. Since the daily intake of radioactivity by exposed population groups, averaged over a year, constitutes an appropriate criterion for the case where the FRC radiation protection guides apply, the 12-month average serves as a basis for comparison.

Discussion of current data

In table 2, surveillance results are given for strontium-90 and cesium-137 for March 1972 and the 12-month period, April 1971 to March 1972. Except where noted, the monthly average represents a single sample for the sampling station. Strontium-89, iodine-131 and barium-140 data have been omitted from table 2 since levels at the great majority of the stations for March 1972 were below the respective practical reporting levels. Table 3 gives monthly averages for those stations at which strontium-89, iodine-131, and barium-140 were detected.

Table 3. Strontium-89, iodine-131 and barium-140 in milk, March 1972

Sampling location	Concentration (pCi/liter)		
	Strontium-89	Iodine-131	Barium-140
Calif: Del Norte (State)	9		
Colo: East (State)			40 (2)[a]
Northwest (State)			40
Kans: Hays	8		
Ky: Louisville (PMN)		6 (2)	
Tenn: Clinton (State)		15 (2)	
Fayetteville (State)		10 (3)	

[a] Number in parenthesis indicates number of samples.

Strontium-90 monthly averages ranged from 0 to 16 pCi/liter in the United States for March 1972 and the highest 12-month average was 17 pCi/liter (Little Falls, Minn.), representing 8.5 percent of the Federal Radiation Council radiation protection guide. Cesium-137 monthly averages ranged from 0 to 54 pCi/liter in the United States for March 1972. The highest 12-month average was 54 pCi/liter (Southeast Florida) representing 1.5 percent of the value derived from the recommendations given in the Federal Radiation Council report. Of particular interest are the consistently higher cesium-137 levels that have been observed in Florida (*8*) and Jamaica.

Acknowledgement

Appreciation is expressed to the personnel of the following agencies who provide data for their milk surveillance networks:

Bureau of Radiological Health
Division of Environmental Sanitation
California State Department of Health

Radiation Protection Division
Canadian Department of National Health and Welfare

Radiological Health Section
Division of Occupational and Radiological Health
Colorado Department of Health

Radiological Health Services
Division of Medical Services
Connecticut State Department of Health

Radiological and Occupational Health Section
Department of Health and Rehabilitative Services
State of Florida

Bureau of Environmental Sanitation
Division of Sanitary Engineering
Indiana State Board of Health

Division of Radiological Health
Environmental Engineering Services
Iowa State Department of Health

Radiation Control Section
Environmental Health Division
Kansas State Department of Health

Radiological Health Services
Division of Occupational Health
Michigan Department of Health

Radiation Control Section
Division of Environmental Health
State of Minnesota Department of Health

Bureau of Radiological Pollution Control
New York State Department of Environmental Conservation

Environmental Radiation Surveillance Program
Division of Sanitation and Engineering
Oregon State Board of Health

Radiological Health Section
Bureau of Environmental Health
Pennsylvania Department of Public Health

Radiological Health Services
Division of Preventable Diseases
Tennessee Department of Public Health

Division of Occupational Health
Environmental Health Services
Texas State Department of Health

Radiation Control Section
Division of Health
Washington Department of Social and Health Services

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Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates, along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides. Programs reported in *Radiation Data and Reports* are as follows:

Program	Period reported	Issue
California Diet Study	July–December 1970	November 1971
Carbon-14 in Total Diet and Milk	July–December 1971	May 1972
Connecticut Standard Diet	January–December 1970	December 1971
Institutional Total Diet	October–December 1971 and 1971 Annual Summary	June 1972
Radiostrontium in Milk	January–December 1970	April 1972
Strontium-90 in Tri-City Diets	January–December 1970	November 1971

SECTION II. WATER

The Environmental Protection Agency and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2–4*) set the limits for approval of a drinking water supply containing radium-226 and strontium-90 at 3 pCi/liter and 10 pCi/liter, respectively. Higher concentrations may be acceptable if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence[1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity, except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities reported in *Radiation Data and Reports* are listed below.

Water sampling program	Period reported	Issue
Colorado River Basin	1968	March 1972
Interstate Carrier Drinking Water	1971	May 1972
Kansas	January–December 1970	December 1971
Michigan	January–June 1970	November 1971
New York	July–December 1970 and January–June 1971	May 1972
North Carolina	January–December 1967	May 1969
Radioactivity in California Waters	January–December 1970	June 1972
Radioactivity in Florida Waters	1969	January 1972
Radiostrontium in Tap Water, *HASL*	January–June 1971	April 1972
Tritium in Community Water Supplies	1969	December 1970
Tritium Surveillance System	October–December 1971	May 1972
Washington	July 1969–June 1970	March 1972

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[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90, respectively.

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Gross Radioactivity in Surface Waters of the United States November 1971

Office of Water Programs
Environmental Protection Agency

The monitoring of gross radioactivity in surface waters of the United States was initiated in 1957 as part of the Water Pollution Surveillance System (formerly National Water Quality Network) of the U.S. Public Health Service. Currently, the program is operated by the U.S. Environmental Protection Agency, Office of Water Programs. Regional offices of the Environmental Protection Agency are responsible for the collection of samples and the entering of the resulting data into the analytical storage and retrieval system. Radioactivity analyses are performed in the centralized radioactivity laboratories of the Office of Water Programs (Cincinnati, Ohio).

The regular reporting of gross radioactivity data in *Radiological Health Data and Reports* was terminated with the publication of data for October 1968 (April 1969 issue). With the publication of data for January 1971, this activity was resumed as a monthly report series. The unpublished data for the time interval of November 1968 through December 1970 will be the subject of a future summary article.

Table 1 presents the gross alpha and beta results for samples collected from 10 rivers

Table 1. Gross radioactivity in U.S. surface waters, November 1971

River and station	Number of grab samples	Gross alpha radioactivity (pCi/liter)				Gross beta radioactivity (pCi/liter)			
		Suspended solids		Dissolved solids		Suspended solids		Dissolved solids	
Clinch River:									
Kingston, Tenn	[a]3	<0.6	(<0.3, <1.4)	<1.0	(<0.3, <2.0)	<4	(<3,5)	<5	(<4,6)
Colorado River:									
Utah-Colo. State Line	1	<3		16		<4		13	
Moab Highway Bridge, Utah	[a]4	<2	(<1, <4)	<4	(<3, <7)	<5	(<3,11)	<11	(<3,16)
Moab Mill Creek, Utah	[a]4	<2	(<.4,4)	<5	(<3,7)	<5	(<4,8)	<15	(<3,26)
Lake Granby, Colo	1	<2		<2		<3		<3	
Dolores River:									
Bedrock, Colo	[a]4	<2	(<.3,2)	19	(8,28)	12	(5,29)	45	(15,73)
Gateway, Colo	[a]4	<2	(<.3,3)	22	(13,31)	<12	(<3,35)	50	(8,82)
Silt, Colo	1	<.3		4		3		13	
Mississippi River:									
Dubuque, Iowa	1	2		3		3		6	
Burlington, Iowa	1	3		3		7		7	
Ohio River:									
Cincinnati, Ohio	[a]4	<2	(<.6, <2)	<3	(<3, <4)	<3	(<3, <3)	<6	(<4,9)
Roanoke River:									
John Kerr Dam, Va	[a]5	<1	(<.3, <2)	<2	(<.3, <4)	<3	(<2, <6)	<6	(<3,10)
San Miguel River:									
Above Uravan, Colo	[a]4	<1	(<.3, <2)	<12	(<2,24)	<3	(<3, <4)	<11	(<3,19)
Below Uravan, Colo	[a]4	<2	(<2,4)	<15	(<10,32)	<12	(<3,19)	28	(13,69)
Naturita, Colo	[a]4	<1	(<.3, <1)	<4	(<1, <6)	<3	(<3, <3)	<8	(<7, <9)
St. Lawrence River:									
Massena, NY	[a]4	<1	(<.3, <2)	<2	(<1, <4)	<3	(<2, <3)	5	(4,6)
White River:									
Watson, Utah	1	<2		<8		6		9	
Yampa River:									
Maybell, Colo	1	<1		1		7		6	

[a] Where more than one sample is analysed during the month, the minimum and maximum are in parentheses.

during November 1971. The analytical procedures used for determining gross alpha and beta radioactivity are described in the 13th Edition of *Standard Methods for the Examination of Water and Wastewater* (*1*). Results are reported for the date of counting and are not corrected to the date of collection. The sensitivity in counting is that defined by the National Bureau of Standards, Handbook 86 (*2*) and is calculated to be <0.2 pCi/liter for gross alpha radioactivity and <1 pCi/liter for gross beta radioactivity measurements.

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SECTION III. AIR AND DEPOSITION

Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta-radioanalysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the Environmental Protection Agency, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization.

In addition to those programs presented in this issue, the following programs were previously covered in *Radiation Data and Reports*.

Network	Period	Issue
Fallout in the United States and other areas, *HASL*	January–December 1970	December 1971
Mexican Air Monitoring Program	February–December 1971	May 1972
Plutonium in Airborne Particulates	July–September 1971	April 1972
Surface Air Sampling Program, 80th Meridian Network, *HASL*	January–December 1969	February 1972

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1. Radiation Alert Network
March 1972

Division of Atmospheric Surveillance
Environmental Protection Agency

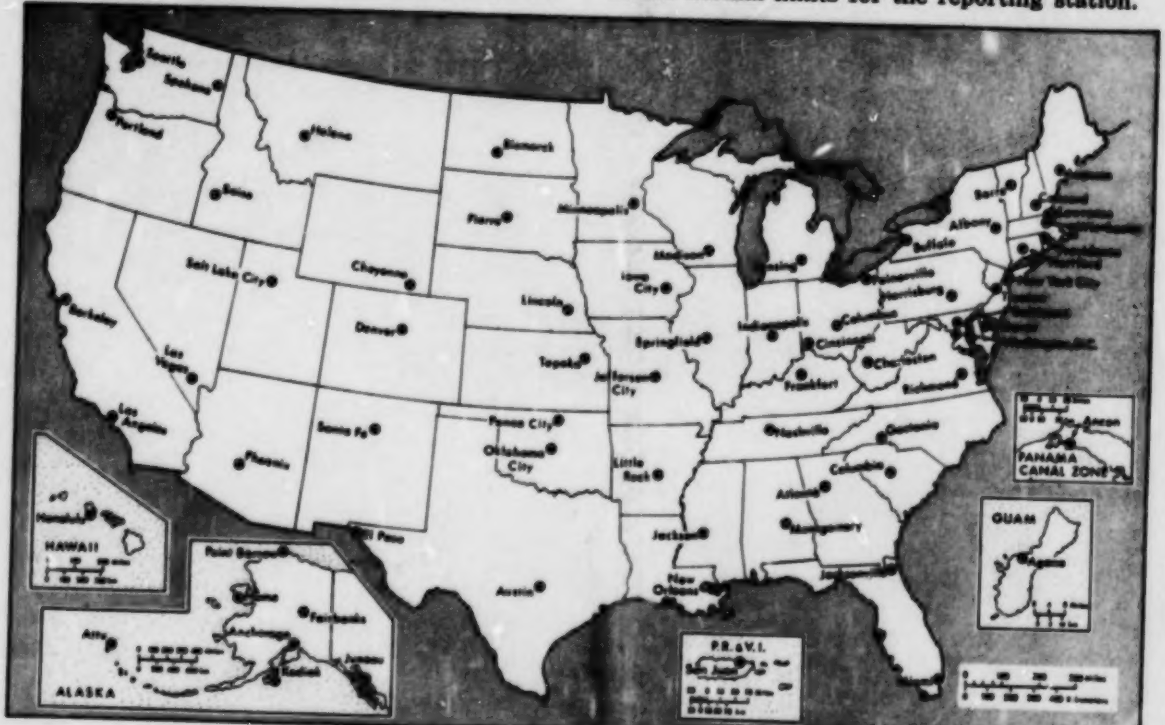
Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Alert Network (RAN) which regularly gathers samples at 70 locations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

The station operators perform "field estimates" on the airborne particulate samples at 5 hours after collection, when most of the radon daughter products have decayed, and at 29 hours after collection, when most of the thoron daughter products have decayed. They also perform field estimates on dried precipitation samples and report all results to appropriate Environmental Protection Agency officials by mail or telephone depending on levels found. A compilation of the daily field estimates is available upon request from the Air Quality Information Systems Branch, Division of Atmospheric Surveillance, EPA, Research Triangle Park, North Carolina 27711. A detailed description of the sampling and analytical procedures was presented in the March 1968 issue of *Radiological Health Data and Reports.*

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate technique during March 1972.

Stations that reported high readings in March are (air) Santa Fe, N. Mex.—17 pCi/m³; (precipitation) Nashville, Tenn.—38 nCi/m²; Oklahoma City, Okla.—25 nCi/m²; and Portland, Oreg.—20, 22, and 80 nCi/m². These elevated levels are attributed to a nuclear detonation on March 18, 1972 by the People's Republic of China.

All other field estimates reported were within normal limits for the reporting station.


Seattle
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Helena
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Pierre
Minneapolis
Salt Lake City
Cheyenne
Berkeley
Lincoln
Denver
Las Vegas
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Los Angeles
Santa Fe
Ponca City
Oklahoma City
Phoenix
El Paso
Austin
Honolulu
HAWAII
Point Barrow
Fairbanks
Anchorage
Attu
Kodiak
Juneau
ALASKA
Madison
Iowa City
Lansing
Buffalo
Albany
Barre
Painesville
Harrisburg
New York City
Springfield
Indianapolis
Columbus
Cincinnati
Charleston
Frankfort
Jefferson City
Richmond
Nashville
Charlotte
Columbia
Atlanta
Montgomery
Little Rock
Jackson
New Orleans
Jacksonville
Ancon
PANAMA CANAL ZONE
GUAM
Agana
P.R. & V.I.
San Juan

Figure 1. Radiation Alert Network sampling stations

Table 1. Gross beta radioactivity in surface air and precipitation, March 1972

Station location		Number of samples	Gross beta radioactivity (5-hour field estimate) (pCi/m³)			Precipitation				
						Number of samples	Total depth (mm)	Field estimation of deposition		
			Maximum	Minimum	Average[a]			Number of samples	Depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	22	2	0	1	5	49	5	49	7
Alaska:	Anchorage	2	0	0	0	0				
	Attu Island	15	0	0	0	0				
	Fairbanks	0				0				
	Juneau	19	8	0	1	7	107	7	107	24
	Kodiak	0				0				
	Nome	0				0				
	Point Barrow	0				0				
Ariz:	Phoenix	13	14	2	5	0				
Ark:	Little Rock	16	6	0	1	0				
Calif:	Berkeley	23	1	2	0	1	5	1	5	0
	Los Angeles	21	2	0	1	0				
C.Z:	Ancon	18	0	0	0	0				
Colo:	Denver	25	6	0	2	1	3	(b)		
Conn:	Hartford	22	1	0	0	11	131	11	131	0
Del:	Dover	22	0	0	0	0				
D.C:	Washington	26	0	0	0	0				
Fla:	Jacksonville	21	2	0	1	3	96	3	96	37
	Miami	18	1	0	0	3	32	3	32	0
Ga:	Atlanta	23	3	1	2	0				
Guam:	Agana	0				0				
Hawaii:	Honolulu	21	12	0	1	2	56	(b)		
Idaho:	Boise	0				0				
Ill:	Springfield	11	2	1	1	0				
Ind:	Indianapolis	22	1	0	0	0				
Iowa:	Iowa City	22	1	0	0	3	46	2	35	0
Kans:	Topeka	22	5	1	2	5	33	5	33	7
Ky:	Frankfort	0				0				
La:	New Orleans	19	0	0	0	8	150	1	7	0
Maine:	Augusta	23	0	0	0	12	175	11	168	0
Md:	Baltimore	10	2	0	1	5	50	5	50	0
Mass:	Lawrence	23	2	0	0	6	110	5	81	0
	Winchester	22	2	0	0	8	167	8	167	0
Mich:	Lansing	22	0	0	0	0				
Minn:	Minneapolis	23	1	0	0	2	18	2	18	5
Miss:	Jackson	21	3	0	1	6	157	6	157	23
Mo:	Jefferson City	23	2	0	1	6	61	6	61	5
Mont:	Helena	21	1	0	1	3	20	3	20	0
Nebr:	Lincoln	18	7	1	2	0				
Nev:	Las Vegas	22	6	0	2	0				
N.H:	Concord	0				0				
N.J:	Trenton	22	1	0	0	10	96	10	96	4
N. Mex:	Santa Fe	15	17	0	2	1	3	1	3	0
N.Y:	Albany	15	0	0	0	0				
	Buffalo	20	0	0	0	0				
	New York City	0				0				
N.C:	Gastonia	18	6	0	2	7	81	(b)		
N. Dak:	Bismarck	21	1	0	0	4	48	4	48	2
Ohio:	Cincinnati	0				0				
	Columbus	4	0	0	0	0				
	Painesville	22	0	0	0	8	77	8	77	21
Okla:	Oklahoma City	7	14	1	2	1	14	1	14	25
	Ponca City	20	6	1	2	2	21	2	21	0
Oreg:	Portland	22	2	0	0	10	116	10	116	190
Pa:	Harrisburg	18	1	0	0	2	30	2	30	5
P.R:	San Juan	18	4	0	2	0				
R.I:	Providence	22	1	0	0	0				
S.C:	Columbia	18	2	0	1	3	41	3	41	7
S. Dak:	Pierre	22	3	0	1	0				
Tenn:	Nashville	21	1	0	0	11	118	11	118	66
Tex:	Austin	19	9	0	3	0				
	El Paso	3	4	1	1	0		(b)		
Utah:	Salt Lake City	21	2	0	1	5	24	5	24	9
Vt:	Barre	19	1	0	0	11	106	11	106	15
Va:	Richmond	22	1	0	0	1	9	1	9	4
Wash:	Seattle	12	3	0	0	7	77			
	Spokane	23	2	0	1	0		(b)		
W. Va:	Charleston	22	9	0	1	9	53	9	53	9
Wisc:	Madison	22	1	0	0	8	51	8	51	4
Wyo:	Cheyenne	21	7	0	2	4	13	4	13	7
Network summary		1,144	17	0	1	201	74	5	61	12

[a] The monthly average is calculated by weighting the field estimates of individual air samples with length of sampling period.
[b] This station is part of the tritium surveillance system. No gross beta measurements are done.

2. Canadian Air and Precipitation Monitoring Program,[1] March 1972

Radiation Protection Division
Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 2), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*1–5*).

A summary of the sampling procedures and methods of analysis was presented in the May 1969 issue of *Radiological Health Data and Reports.*

Surface air and precipitation data for March 1972 are presented in table 2.

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[1] Prepared from information and data obtained from the Canadian Department of National Health and Welfare, Ottawa, Canada.

Table 2. Canadian gross beta radioactivity in surface air and precipitation, March 1972

Station	Number of samples	Air surveillance gross beta radioactivity (pCi/m³)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentration (pCi/liter)	Total deposition (nCi/m²)
Calgary	13	0.9	0.0	0.1	65	0.8
Coral Harbour	12	.1	.0	.1	NS	NS
Edmonton	12	.3	.0	.1	85	1.1
Ft. Churchill	13	.2	.1	.1	91	.3
Fredericton	7	.1	.1	.1	230	48.9
Goose Bay	11	.2	.1	.1	105	7.8
Halifax	13	.3	.0	.1	570	129.7
Inuvik	NS				217	3.2
Montreal	12	.4	.0	.0	23	2.6
Moosonee	12	.1	.0	.1	13	.8
Ottawa	11	.3	.0	.1	11	1.1
Quebec	11	.4	.1	.1	13	1.9
Regina	12	.2	.0	.1	331	.4
Resolute	13	.1	.0	.1	15	.1
St. John's, Nfld	8	.1	.0	.1	16	2.1
Saskatoon	12	.1	.0	.1	92	.7
Sault Ste. Marie	10	.1	.0	.1	15	1.3
Thunder Bay	10	.1	.1	.1	20	.8
Toronto	12	.3	.1	.1	19	1.6
Vancouver	11	.4	.0	.1	19	3.4
Whitehorse	12	.1	.0	.1	78	.6
Windsor	11	.2	.0	.1	13	1.0
Winnipeg	12	.2	.0	.1	309	4.3
Yellowknife	9	.1	.1	.1	21	.3
Network summary	256	0.9	0.0	0.1	83	9.3

NS, no sample.

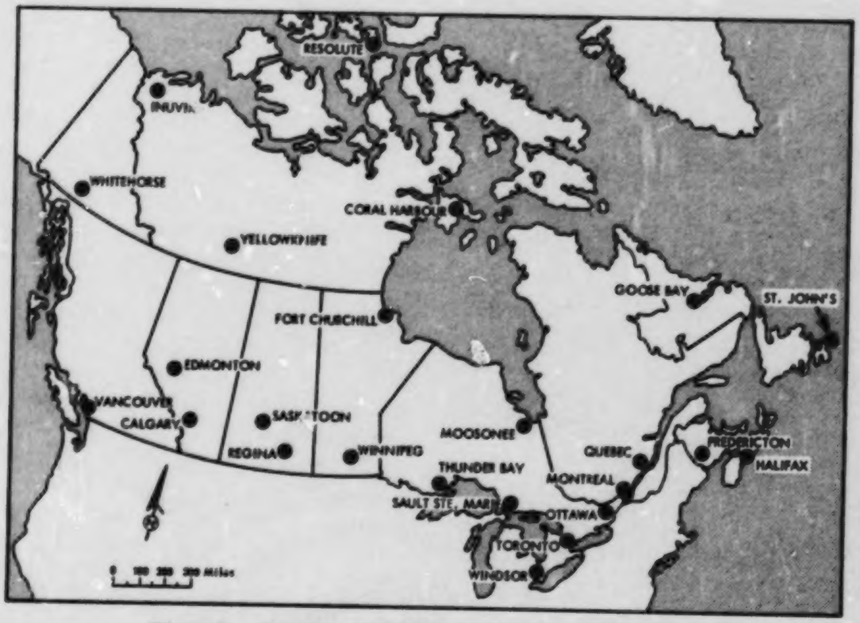
RESOLUTE
INUVIK
WHITEHORSE
CORAL HARBOUR
YELLOWKNIFE
GOOSE BAY
ST. JOHN'S
FORT CHURCHILL
EDMONTON
VANCOUVER
CALGARY
SASKATOON
REGINA
WINNIPEG
MOOSONEE
QUEBEC
FREDERICTON
HALIFAX
THUNDER BAY
MONTREAL
SAULT STE. MARIE
OTTAWA
TORONTO
WINDSOR
0 100 200 300 Miles

Figure 2. Canadian air and precipitation sampling stations

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3. Pan American Air Sampling Program March 1972

Pan American Health Organization and
U.S. Environmental Protection Agency

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the Environmental Protection Agency (EPA) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 3. Analytical techniques were described in the March 1968 issue of *Radiological Health Data and Reports*. The March 1972 air monitoring results from the participating countries are given in table 3.

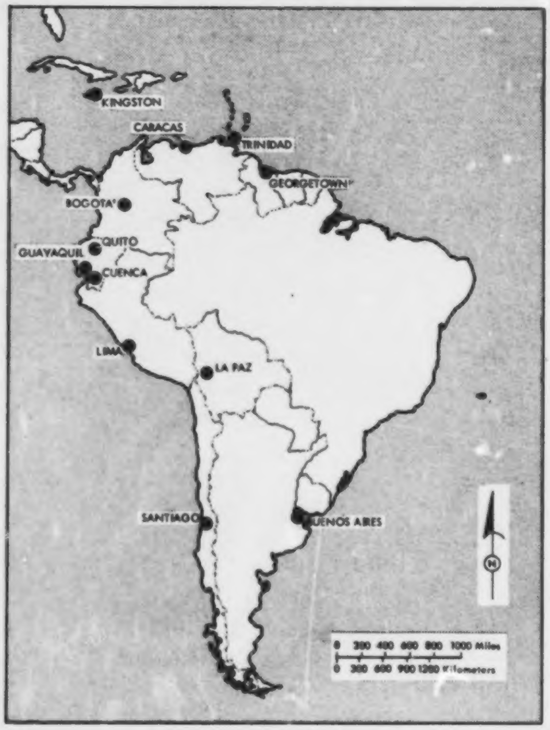

Figure 3. Pan American Air Sampling Program stations

Table 3. Summary of gross beta radioactivity in Pan American surface air, March 1972

Station location		Number of samples	Gross beta radioactivity (pCi/m³)		
			Maximum	Minimum	Average[a]
Argentina:	Buenos Aires	0			
Bolivia:	La Paz	16	0.04	0.00	0.02
Chile:	Santiago	30	.21	.05	.12
Colombia:	Bogota	21	.05	.00	.02
Ecuador:	Cuenca	1	.00	.00	.00
	Guayaquil	10	.06	.00	.02
	Quito	16	.01	.00	.00
Guyana:	Georgetown	6	.01	.00	.01
Jamaica:	Kingston	0			
Peru:	Lima	0			
Venezuela:	Caracas	14	.05	.00	.02
West Indies:	Trinidad	0			
Pan American summary		114	0.21	0.00	0.04

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values less than 0.005 pCi/m³ are reported and used in averaging as 0.00 pCi/m³.

4. California Air Sampling Program March 1972

Bureau of Radiological Health
California State Department of Public Health

The Bureau of Radiological Health of the California State Department of Public Health with the assistance of several cooperating agencies and organizations operates a surveillance system for determining radioactivity in airborne particulates. The air sampling locations are shown in figure 4.

All air samples are sent to the Sanitation and Radiation Laboratory of the State Department of Public Health where they are analyzed for their radioactive content.

Airborne particles are collected by a con-

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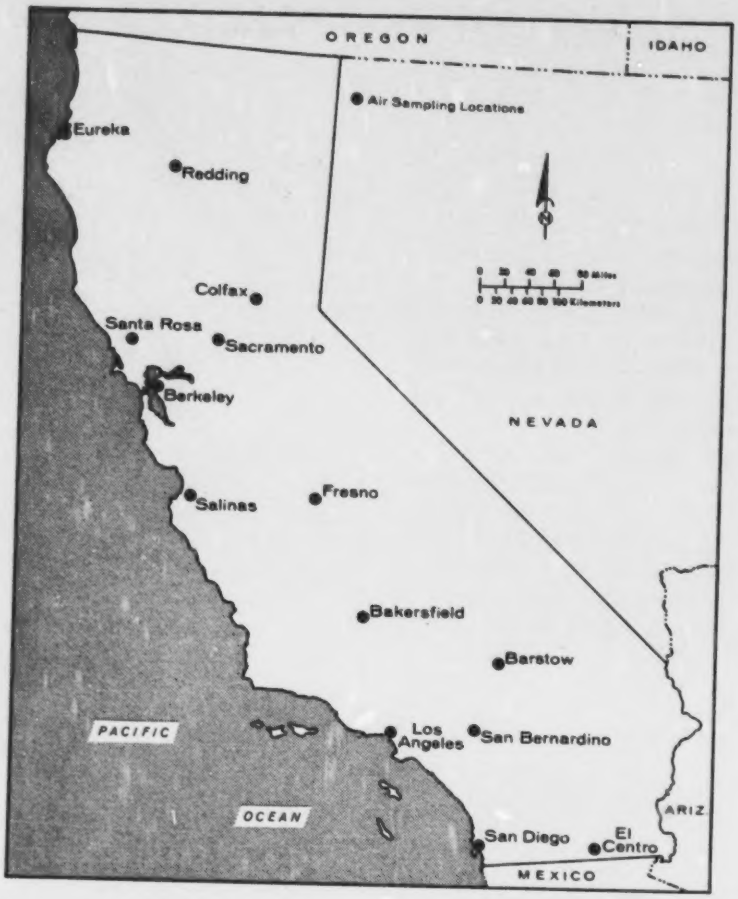
OREGON
IDAHO
Air Sampling Locations
Eureka
Redding
Colfax
Santa Rosa
Sacramento
Berkeley
NEVADA
Salinas
Fresno
Bakersfield
Barstow
PACIFIC
Los Angeles
San Bernardino
OCEAN
ARIZ.
San Diego
El Centro
MEXICO
Miles
Kilometers

Figure 4. California air sampling program stations

tinuous sampling of air filtered through a 47 millimeter membrane filter, 0.8 micron pore size, using a Gast air pump of about 2-cubic-feet per minute capacity, or 81.5 cubic meters per day. Air volumes are measured with a direct reading gas meter. Filters are replaced every 24 hours except on holidays and weekends. The filters are analyzed for gross alpha and beta radioactivity. Analyses are normally made 72 hours after the end of the collection period. The daily samples are then composited into a monthly sample. A gamma scan and an analysis for strontium-89 and strontium-90 are made. Table 4 presents the monthly gross beta radioactivity in air for March 1972.

Table 4. Gross beta radioactivity in California air, March 1972

Station location	Number of samples	Gross beta radioactivity[a] (pCi/m³)		
		Maximum	Minimum	Average
Bakersfield	31	1.10	0.00	0.31
Barstow	31	5.25	.05	.46
Berkeley	30	.15	.00	.06
Colfax	30	.25	.00	.11
El Centro	29	11.04	.09	1.07
Eureka	30	.43	.00	.08
Fresno	31	1.13	.07	.33
Los Angeles	29	.33	.01	.12
Redding	30	.44	.00	.11
Sacramento	31	.91	.01	.19
Salinas	31	1.52	.04	.26
San Bernardino	31	9.64	.02	1.17
San Diego	31	.54	.01	.16
Santa Rosa	31	.76	.00	.12
Summary	426	11.04	0.00	0.33

[a] Single sample taken at Orange, Calif., March 15, 1972, resulted in a gross beta activity of 0.14. This sample is not included in summary.

5. Plutonium in Airborne Particulates October–December 1971

Office of Radiation Programs
Environmental Protection Agency

The Radiation Alert Network (RAN) of the Division of Atmospheric Surveillance, Environmental Protection Agency, routinely collects airborne particulates samples from eleven selected RAN stations for plutonium analyses. The plutonium analyses were initiated in November 1965, and references to the previous results through December 1969 have been published (*6*).

One-half of each individual air filter from the selected stations is sent to the Northeastern Radiological Health Laboratory, Winchester, Mass. The laboratory analyzes a composite of these samples from each station on a quarterly basis. The results for October–December 1971 are presented in table 5. The minimum detectable activities are 0.020 pCi and 0.015 pCi per sample for plutonium-238 and plutonium-239, respectively. The volume of air sampled varies, generally ranging from 20,000 to 30,000 cubic meters per month.

Other coverage in *Radiation Data and Reports:*

Period	Issue
July–December 1970	June 1971
January–March 1971	November 1971
April–June 1971	March 1972
July–September 1971	April 1972

Table 5. Plutonium in airborne particulates October-December 1971

Location		Plutonium-238 (aCi/m³)	Plutonium-239 (aCi/m³)	Plutonium-239/plutonium-238
Alaska:	Anchorage	ND	8 ±2	—
Ariz:	Phoenix	2 ±1	16 ±3	8 ±4
Colo:	Denver	ND	17 ±3	—
Hawaii:	Honolulu	ND	7 ±1	—
La:	New Orleans	2 ±1	19 ±4	10 ±5
Md:	Baltimore	ND	14 ±1	—
N.Y:	Buffalo	ND	16 ±2	—
N.C:	Gastonia	ND	20 ±3	—
S. Dak:	Pierre	ND	15 ±2	—
Tex:	Austin	ND	25 ±2	—
Wash:	Seattle	ND	10 ±1	—

ND, nondetectable.

REFERENCES

(*1*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report of 1959 on the Radioactive Fallout Study Program, CNHW–RP–3. Department of National Health and Welfare, Ottawa, Canada (May 1960).

(*2*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report for 1960 on the Radioactive Fallout Study Program, CNHW–RP–4. Department of National Health and Welfare, Ottawa, Canada (December 1961).

(*3*) MAR, P. G. Annual report for 1961 on the Radioactive Fallout Study Program, CNHW–RP–5. Department of National Health and Welfare, Ottawa, Canada (December 1962).

(*4*) BEALE, J. and J. GORDON. The operation of the Radiation Protection Division Air Monitoring Program, RPD–11. Department of National Health and Welfare, Ottawa, Canada (July 1962).

(*5*) BOOTH, A. H. The calculation of permissible levels of fallout in air and water and their use in assessing the significance of 1961 levels in Canada, RPD–21. Department of National Health and Welfare, Ottawa, Canada (August 1962).

(*6*) BUREAU OF RADIOLOGICAL HEALTH. Plutonium in airborne particulates, April–December 1969. Radiol Health Data Rep 11:552–553 (October 1970).

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Air Surveillance Network,[1] March 1972

Western Environmental Research Laboratory
Environmental Protection Agency

The Air Surveillance Network (ASN), operated by the Western Environmental Research Laboratory (WERL), Las Vegas, Nev., consists of 104 active and 18 standby sampling stations located in 21 western States (figures 1 and 2). The network is operated in support of nuclear testing sponsored by the Atomic Energy Commission (AEC) at the Nevada Test Site (NTS), by the Space Nuclear Systems Office at the Nuclear Rocket Development Station which lies within the NTS, and by the AEC at any other designated testing sites.

The stations are operated by State health department personnel and by private individuals on a contract basis. All samples are mailed

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[1] The ASN is operated under a Memorandum of Understanding (No. AT(26–1)–539) with the Nevada Operations Office, U.S. Atomic Energy Commission.

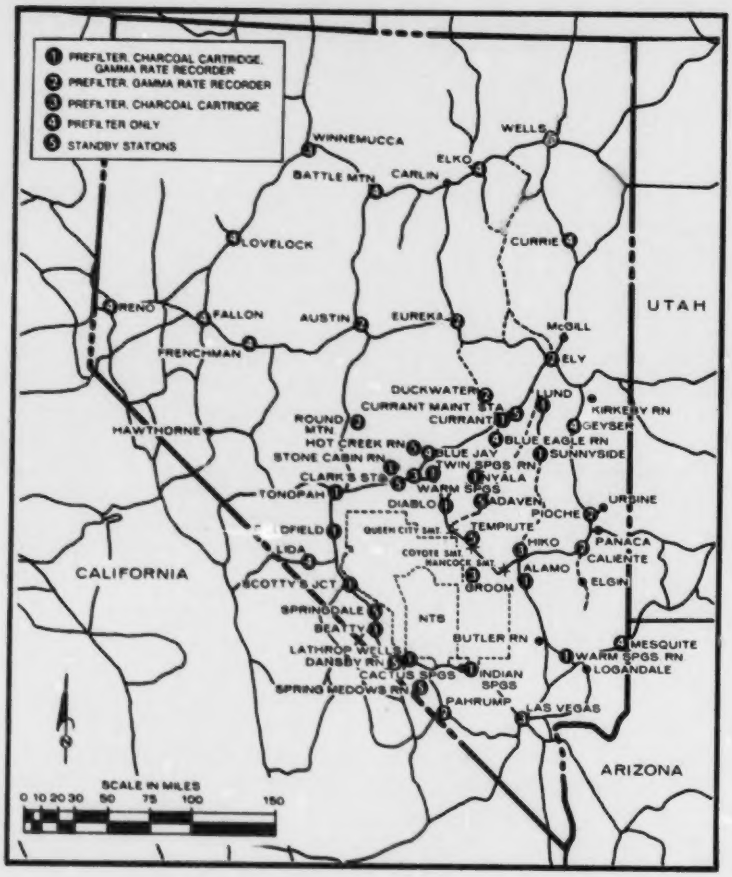
① PREFILTER, CHARCOAL CARTRIDGE, GAMMA RATE RECORDER
② PREFILTER, GAMMA RATE RECORDER
③ PREFILTER, CHARCOAL CARTRIDGE
④ PREFILTER ONLY
⑤ STANDBY STATIONS
WINNEMUCCA
WELLS
ELKO
BATTLE MTN
CARLIN
LOVELOCK
CURRIE
UTAH
RENO
FALLON
AUSTIN
EUREKA
McGILL
FRENCHMAN
ELY
DUCKWATER
CURRANT MAINT STA
LUND
KIRKEBY RN
ROUND MTN
CURRANT
GEYSER
HAWTHORNE
HOT CREEK RN
BLUE EAGLE RN
BLUE JAY
SUNNYSIDE
STONE CABIN RN
TWIN SPGS RN
CLARK'S STA
NYALA
WARM SPGS
TONOPAH
DIABLO
ADAVEN
URSINE
PIOCHE
DFIELD
QUEEN CITY SMT
TEMPIUTE
HIKO
PANACA
LIDA
COYOTE SMT
HANCOCK SMT
CALIENTE
CALIFORNIA
ALAMO
SCOTTY'S JCT
GROOM
ELGIN
SPRINGDALE
NTS
BEATTY
BUTLER RN
MESQUITE
LATHROP WELLS
WARM SPGS RN
DANSBY RN
LOGANDALE
CACTUS SPGS
INDIAN SPGS
SPRING MEDOWS RN
PAHRUMP
LAS VEGAS
ARIZONA
N
SCALE IN MILES
0 10 20 30 50 75 100 150

Figure 1. WERL Air Surveillance Network stations in Nevada

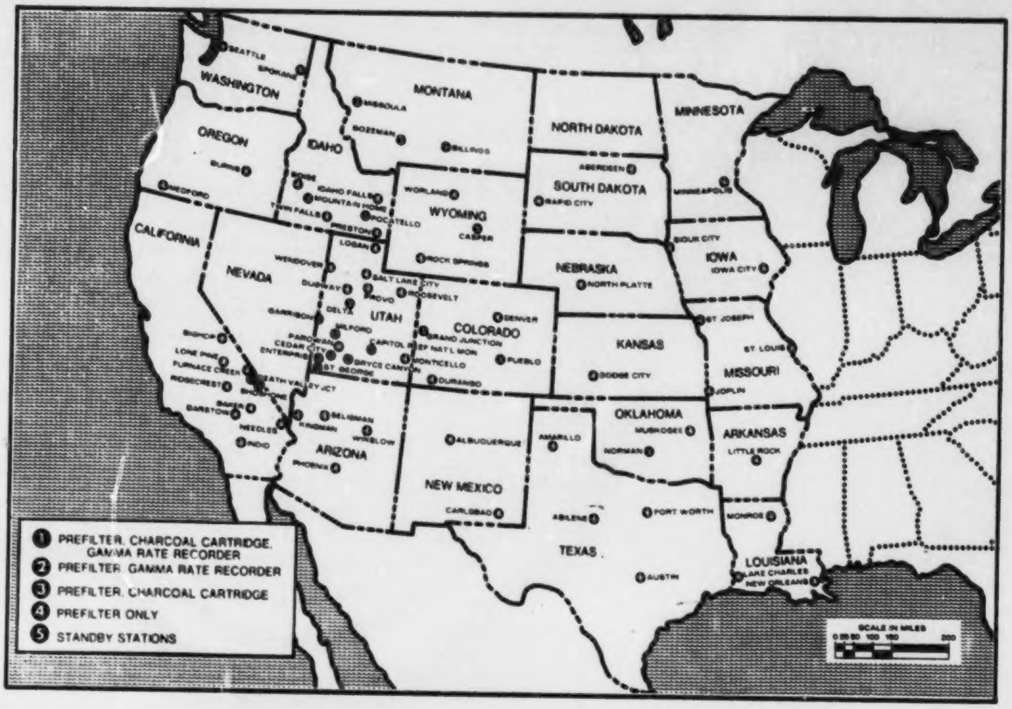

Figure 2. WERL Air Surveillance Network stations outside Nevada

to the WERL unless special retrieval is arranged at selected locations in support of known releases of radioactivity from the NTS. A complete description of sampling and analytical procedures was presented in the February 1972 issue of *Radiation Data and Reports.*

Results

Table 1 presents the monthly average gross beta radioactivity in air particulates for each of the network stations. The highest gross beta radioactivity within the network was 110 pCi/m^3 at Furnace Creek and at Indio, Calif. The minimum reported concentration for gross beta radioactivity is 0.1 pCi/m^3. For averaging purposes, individual concentrations which are below the minimum detectable concentration (0.06 pCi/m^3) are assumed to be equal to the minimum detectable concentration. Averages less than the minimum reported level (0.1 pCi/m^3) are reported as <0.1 pCi/m^3.

From gamma spectrometry results, fission products in varying combinations of neptunium-239, cerium-141, barium-140, tellurium-132, iodine-131, ruthenium-103, and zirconium-95 were identified on samples collected in Arizona, California, Colorado, Idaho, Kansas, Louisiana, Nebraska, Nevada, New Mexico, Oregon, Texas, Utah, Washington, and Wyoming. Table 2 lists the highest concentrations of these radionuclides, which are attributed to a nuclear detonation by the People's Republic of China on March 18, 1972.

Copies of this summary and listings of the daily gross beta and gamma spectrometry results are distributed to EPA regional offices and appropriate State agencies. Additional copies of the daily results may be obtained from the WERL upon written request.

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Table 1. Summary of gross beta radioactivity concentrations in air, March 1972

Location		Number of samples	Concentration (pCi/m³)		
			Maximum	Minimum	Average[a]
Ariz:	Kingman	31	34.0	<0.1	1.8
	Phoenix	30	19.0	<.1	1.5
	Seligman	31	33.0	.1	3.2
	Winslow	31	32.0	<.1	1.7
Ark:	Little Rock	16	.9	<.1	.1
Calif:	Baker	31	10.0	<.1	.7
	Barstow	31	7.8	<.1	.5
	Bishop	31	33.0	<.1	1.5
	Dealth Valley Junction	31	14.0	<.1	1.0
	Furnace Creek	31	110.0	<.1	4.2
	Indio	31	110.0	<.1	4.6
	Lone Pine	29	45.0	<.1	2.0
	Needles	10	9.1	<.1	1.3
	Ridgecrest	31	7.9	<.1	.6
	Shoshone	31	11.0	<.1	.8
Colo:	Denver	25	7.5	<.1	.4
	Durango	31	21.0	.1	1.2
Idaho:	Boise	31	10.0	<.1	.6
	Idaho Falls	30	10.0	.1	.5
	Preston	31	7.6	<.1	.6
	Twin Falls	31	8.4	<.1	.6
Iowa:	Iowa City	21	.3	<.1	.1
	Sioux City	28	.4	<.1	.1
Kans:	Dodge City	31	3.5	<.1	.3
La:	Lake Charles	22	1.7	<.1	.3
	Monroe	22	.5	.1	.1
	New Orleans	19	.4	.1	.2
Minn:	Minneapolis	23	.3	<.1	.1
Mo:	Joplin	31	1.9	<.1	.2
	St. Joseph	31	1.5	<.1	.1
	St. Louis	27	.5	.1	.1
Nebr:	North Platte	26	2.7	.1	.3
Nev:	Alamo	31	5.7	<.1	.6
	Austin	25	5.5	<.1	.3
	Battle Mountain	30	.8	<.1	.2
	Beatty	31	13.0	<.1	1.1
	Blue Eagle Ranch (Currant)	22	3.7	<.1	.6
	Blue Jay	31	5.1	<.1	.4
	Caliente	31	5.8	.1	.5
	Currant Ranch	31	3.3	<.1	.4
	Currie	30	.7	<.1	.2
	Diablo	31	4.5	<.1	.4
	Duckwater	27	2.4	<.1	.2
	Elko	31	1.9	<.1	.2
	Ely	31	3.2	<.1	.3
	Eureka	32	3.6	<.1	.3
	Fallini's Twin Springs Ranch	31	4.5	.1	.6
	Fallon	31	1.3	<.1	.2
	Frenchman Station	31	2.4	<.1	.3
	Geyser Maintenance Station	29	12.0	<.1	.9
	Goldfield	28	7.6	<.1	.5
	Groom Lake	29	4.0	<.1	.5
	Hiko	31	16.0	<.1	.9
	Indian Springs	31	17.0	<.1	1.1
	Las Vegas	23	55.0	<.1	2.0
	Lathrop Wells	30	9.5	<.1	.9
	Lida	31	31.0	<.1	1.7
	Lovelock	31	.9	<.1	.2
	Lund	31	3.2	<.1	.4
	Mesquite	31	8.4	<.1	.7
	Nyala	29	2.3	<.1	.4
	Pahrump	23	11.0	.1	.8
	Pioche	29	7.7	<.1	.6
	Reno	31	2.7	.1	.2
	Round Mountain	30	4.8	<.1	.3
	Scotty's Junction	28	4.9	<.1	.6
	Stone Cabin Ranch	31	4.0	<.1	.4
	Sunnyside	26	2.1	.1	.3
	Tonopah	31	6.2	<.1	.6
	Tonopah Test Range	23	7.2	<.1	.5
	Warm Springs Ranch	31	6.8	<.1	.7
	Wells	31	.9	<.1	.2
	Winnemucca	31	1.3	<.1	.2
N. Mex:	Albuquerque	23	27.0	.1	1.5
	Carlsbad	30	21.0	<.1	2.3
Okla:	Muskogee	31	1.6	<.1	.2
Oreg:	Burns	30	25.0	<.1	1.0
	Medford	27	3.2	<.1	.3
S. Dak:	Aberdeen	28	.4	<.1	.1
	Rapid City	30	1.5	<.1	.2
Tex:	Abilene	28	7.6	<.1	.8
	Amarillo	31	7.0	<.1	.6
	Austin	18	5.1	.1	.5
	Fort Worth	29	3.0	.1	.3

---

[a] See footnote at end of table.

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Table 1. Summary of gross beta radioactivity concentrations in air, March 1972—continued

Location		Number of samples	Concentration (pCi/m³)		
			Maximum	Minimum	Average[a]
Utah:	Bryce Canyon	24	5.6	.1	.7
	Cedar City	30	11.0	.1	.3
	Delta	31	1.7	.1	.3
	Dugway	31	2.2	<.1	.3
	Enterprise	31	10.0	<.1	.6
	Garrison	31	5.3	<.1	.4
	Logan	30	5.1	<.1	.4
	Milford	31	12.0	<.1	.7
	Monticello	22	4.0	<.1	.6
	Parowan	31	20.0	<.1	1.2
	Provo	31	1.8	<.1	.3
	Roosevelt	30	6.2	<.1	.4
	Salt Lake City	31	2.9	.1	.3
	St. George	31	5.2	<.1	.7
	Wendover	30	4.5	<.1	.3
Wash:	Seattle	23	2.8	<.1	.2
	Spokane	23	1.4	<.1	.3
Wyo:	Rock Springs	31	17.0	<.1	.3
	Worland	31	1.2	<.1	.2

[a] Individual values less than the minimum detectable concentration (MDC) are set equal to the MDC for averaging. A monthly average less than the minimum reported value of 0.1 pCi/m³ is reported as <0.1.

Table 2. Concentration of radionuclides in air March 1972

Radionuclides	Maximum concentration (pCi/m³)	Location
Neptunium-239	120	Indio, Calif.
Cerium-141	12	Las Vegas, Nev.
Barium-140	1.1	Seligman, Ariz.
Tellurium-132	2.6	Las Vegas, Nev.
Iodine-131	1.3	Seligman, Ariz.
Ruthenium-103	.3	Seligman, Ariz.
Zirconium-95	2.4	Indio, Calif.

SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are such data as those obtained from human bone sampling, Alaskan surveillance, and environmental monitoring around nuclear facilities.

Offsite Surveillance Around the Nevada Test Site [1] January-June 1968

Western Environmental Research Laboratory, EPA,[2] and Nevada Operations Office, AEC

During January through June 1968, 18 announced nuclear tests were conducted in Nevada by the U.S. Atomic Energy Commission (AEC). Three of these tests[3] and two operations of the Phoebus 2A nuclear rocket engine at the Nuclear Rocket Development Station released radioactivity that was detected in the offsite area surrounding the Nevada Test Site (NTS). Under a memorandum of understanding with the AEC and the Public Health Service (PHS), the Southwestern Radiological Health Laboratory (SWRHL) performed offsite radiological monitoring and surveillance in support of these tests.

Operational procedures

Before each event, mobile ground monitors were positioned downwind. If a release occurred, they conducted a monitoring program directed from the AEC control point. In addition to the routine sampling and monitoring provided within 300 miles of each nuclear event, surveillance was extended as necessary to provide adequate coverage. Measurements were made periodically until radioactivity levels returned to background.

Each monitor was equipped with two Eberline E-500B survey meters, an NE-148 scintillation instrument and a Victoreen Radector, Model No. AGB-50B-Sr. Eberline RM11 exposure-rate recorders at fixed locations documented cloud passage. An Air Force U-3A aircraft was used for aerial cloud tracking and two SWRHL Turbo-Beech aircraft provided sampling and long-range tracking.

The Air Surveillance Network (ASN) operated in most of the States west of the Mississippi River (figure 1). The air samplers used were positive displacement vacuum pumps with an average flowrate of 10-cubic feet per minute. The filter media used were a 4-inch Whatman 541 filter paper and an MSA charcoal cartridge. One hundred and seventy-eight samples were collected from about 30 locations in the established milk sampling network. Samples were taken from both commercial dairies and private producers. Vegetation samples were collected after known releases of radioactivity to help delineate the fallout pattern. A total of 426 samples of both potable and nonpotable water was collected from about 80 locations.

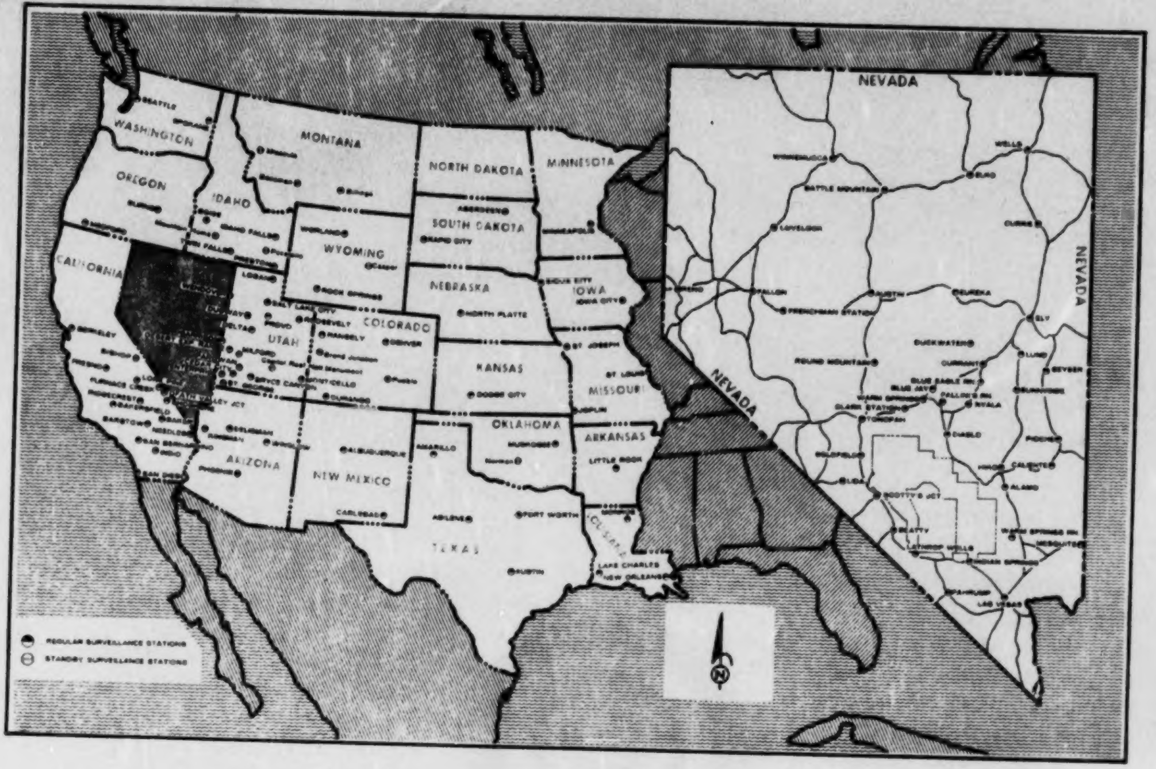
Approximately 122 residents in the offsite areas wore film badges and five film badges were placed at each of 107 dosimetry stations. One hundred of these stations were also equipped with three EG&G model TL-12

---

[1] This article is a summary of report No. SWRHL-81r, "Off-site Surveillance Activities of the Southwestern Radiological Health Laboratory from January through June 1968."

[2] Formerly the Southwestern Radiological Health Laboratory of the U.S. Department of Health, Education, and Welfare, Public Health Service, Bureau of Radiological Health.

[3] These three tests, Hupmobile, Cabriolet and Buggy I, were reported in reference (*1*).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BEATTY
LATHROP WELLS
INDIAN SPRINGS
LAS VEGAS
HIKO
CALIENTE
ALAMO
PIOCHE
WARM SPRINGS
MESQUITE
REGULAR SURVEILLANCE STATIONS
STANDBY SURVEILLANCE STATIONS
N

Figure 1. **WERL air surveillance network stations**

thermoluminescent dosimeters (TLD). The film badge used contained DuPont type 545 film and has a 30 mR lower limit of detection.

A PHS medical officer was available to investigate reports of injuries to persons alleged to be a result of the test series and to maintain liaison with local physicians. No injuries were reported. Veterinarian services were also provided by the PHS to conduct wildlife and domestic livestock investigations.

Analytical procedures

All samples were returned to the SWRHL in Las Vegas for analysis. Air sample particulate filters were counted for beta radioactivity. Selected particulate filters, all charcoal cartridges, water, and milk samples were analyzed for gamma-emitting isotopes. Gamma-ray spectra were evaluated using a matrix technique which allowed for the simultaneous determination of eight nuclides. In addition to gamma analysis, water samples were analyzed for gross alpha and beta radioactivity.

Results

Radioactive material was released offsite following one underground nuclear event and after two Plowshare cratering experiments. These were Hupmobile on January 18, Cabriolet on January 26, and Buggy I on March 12. Two power operations of the Phoebus 2A nuclear rocket reactor released radioactive material detected offsite on June 8 and June 26.

The maximum concentration of gross beta in air was 33,000 pCi/m^3 at Stone Cabin Ranch about 16 miles west and 5 miles north of Warm Springs, Nev. This activity was released by the Cabriolet experiment (table 1).

The maximum external gamma radiation level measured at a populated location during

Table 1. Highest levels of air sampling results in off-NTS areas (based on iodine-131), January through June 1968

Event, date time-on/off	Location azimuth—distance[a]	Collector[b]	Average concentrations during collection period (pCi/m³)					
			Gross beta	Iodine-131	Tellurium-132	Iodine-133	Barium-140	Tungsten-187
Cabriolet 1/26 1020/1500	Stone Cabin Ranch, Nev. 354°—64 miles	PF CC	33,000	290 72	180 56	2,500 2,900	210 37	14,000 4,900
Cabriolet 1/26 0730/1620	Clark Station, Nev. 358°—60 miles	PF CC	15,000	150 110	250 69	2,000 3,300	160 65	9,300 3,600
Buggy I 3/12 1037/1545	Warm Springs, Nev. 360°—81 miles	PF CC	12,000	75 22	120 26	610 310	61 14	3,600 2,200
Buggy I 3/12 1105/1305	Reed Ranch, Nev. 14°—53 miles	PF CC	19,000	46 31	72 40	250 380	5.1 3.1	2,300 1,200
Buggy I 3/12 0705/1615	Blue Jay, Nev. 4°—91 miles	PF CC	3,900	23 20	29 25	160 300	12 7.5	1,500 960

[a] Azimuth and distance from surface zero.
[b] PF, particulate filter; CC, charcoal cartridge.

this period was 65 mR/h following Carbiolet on January 26. This level was recorded by a permanent gamma-ray exposure rate recorder at Clark Station, Nev. This level occurred at 1010 hours on January 26, 10 minutes after cloud arrival and approximately 2 hours and 10 minutes after detonation. By 1030 hours, this level had dropped to about 2 mR/h. A monitor using a portable survey instrument observed a maximum reading of about 43 mR/h during cloud passage near the same location (table 2).

Table 2. Highest levels of ground monitoring results in off-NTS areas, January through June 1968 (readings from portable instruments)

Event and date (1968)	Location	Net gamma radioactivity reading (mR/h)
Cabriolet January 26	16 miles west of Warm Springs, Nev. (unpopulated)	43
Cabriolet January 26	Stone Cabin Ranch, Warm Springs, Nev.	20
Buggy I March 12	4 miles east of Warm Springs, Nev. (unpopulated)	8.5
Hupmobile January 18	4 miles west of Lathrop Wells, Nev. (unpopulated)	.7

The maximum concentration of iodine-131 in milk was 630 pCi/liter from a sample collected at Deeth, Nev. after Cabriolet (table 3).

No water samples collected from sources used for human consumption contained radioactivity attributable to any of the above nuclear events.

The highest exposure measured by a dosimetry device during this period was 8 mR measured by a TLD at Clark Station following Cabriolet. This exposure included that due to cloud passage plus 7 days of residual exposure following cloud passage.

Table 3. Highest levels of milk sample results in off-NTS areas, January through June 1968

Event and location	Date milked (1968)	Concentration (pCi/liter)	
		Iodine-131	Iodine-133
Cabriolet Deeth, Nev.	2/8	630	20
Buggy I Wells, Nev.	3/15	550	1,600
Cabriolet Deeth, Nev.	2/1	160	90
Cabriolet Eureka, Nev.	1/28	110	640
Cabriolet Pancake Summit, Nev.	1/27	110	230
Buggy I Pancake Summit, Nev.	3/15	100	260

Conclusions

Surveillance does not indicate that any individual in an offsite area received an exposure which exceeded the guides established by the AEC and/or recommended by the Federal Radiation Council.

REFERENCE

(1) PUBLIC HEALTH SERVICE, BUREAU OF RADIOLOGICAL HEALTH. Offsite surveillance for three events at the Nevada Test Site, January and March 1968. Radiol Health Data Rep 10:125–127 (March 1969).

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Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission (AEC) receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the "AEC Manual."[1]

A summary of environmental radioactivity data follow for the Brookhaven National Laboratory.

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[1] Title 10, Code to Federal Regulations, Part 20, "Standards for Protection Against Radiation" contains essentially the standards published in Chapter 0524 of the AEC Manual.

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1. Brookhaven National Laboratory[2]
July-December 1968

Associated Universities, Inc.
Uptown, N.Y.

The Brookhaven National Laboratory (BNL) operations may affect the environmental levels of radiation in three ways: (1) by radioactivity in the cooling air from the research reactors, (2) by radiation from an ecology forest gamma-ray source, and (3) by low-level radioactive liquid wastes released to a stream that forms one of the headwaters of the Peconic River (figure 1). The radiation levels resulting from reactor air effluent and the ecology forest source are monitored continuously by four stations located at the site boundary. The liquid waste effluent from the laboratory sewage processing plant is monitored continuously at the point where the stream leaves the site.

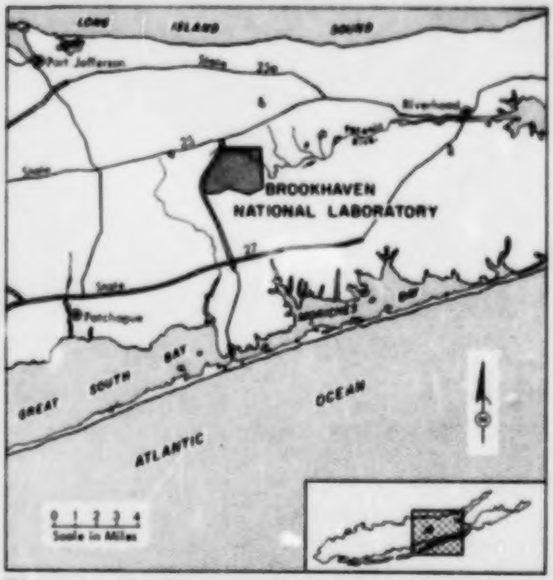

Figure 1. Brookhaven National Laboratory and surrounding area

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[2] Summarized from "Effects of Brookhaven National Laboratory on Environmental Levels of Radioactivity during the Second Half of 1968," Associated Universities, Inc., Upton, N.Y. 11973.

Area monitoring

The average weekly radiation levels at the Brookhaven National Laboratory site perimeter (figure 1), due to laboratory operations, are given in table 1. Radiation levels at the northeast perimeter are somewhat greater than at other monitoring stations due to a cesium-137 source located in the nearby forest. The radiation levels at this location were 17 percent of the established Atomic Energy Commission (AEC) radiation protection standard of 500 mrem/a for individuals in the general population. The low levels at the other three perimeter stations are attributed to the Brookhaven Graphite Research Reactor being on standby status during almost the entire period. Values of radiation background levels undisturbed by laboratory operations also have been included in table 1 for purposes of comparison.

Water monitoring

The liquid waste effluent from the laboratory sewage processing plant is monitored continuously at the point where the stream leaves the BNL site. The average concentration and total amount of gross beta radioactivity in the liquid waste effluent, at the site boundary, are shown in table 2 for July–December 1968.

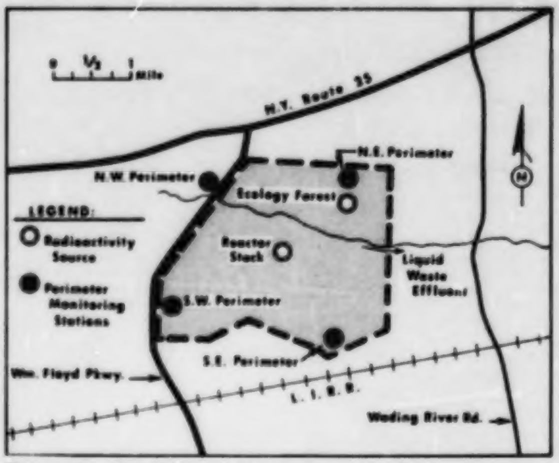

Figure 2. Brookhaven National Laboratory monitoring station locations

Analysis of composite samples of the effluent has shown that, on the average, less than 20 percent of the radioactivity consists of strontium-90 and that no appreciable amounts of radioactive iodine or bone-seeking radionuclides, such as radium, are present. Under these conditions, the applicable AEC radiation protection standard for discharge of liquid waste to uncontrolled areas would be 1 nCi/liter. The observed concentration at BNL was 1 percent of the standard.

Table 1. External gamma radioactivity at BNL site perimeter due to laboratory operations,[a] July-December 1968

1968	Average exposure rates (mR/week)			
	Northwest perimeter	Southwest perimeter	Southeast perimeter	Northeast perimeter
July	0.00	0.00	0.00	1.92
August	.00	.00	.00	2.11
September	.00	.00	.00	1.95
October	.00	.00	.00	1.68
November	.02	.00	.00	1.52
December	.00	.00	.00	1.27
Highest weekly reading (July–December)	0.08	0.00	0.00	2.28
Average undisturbed background (July–December)	1.75	1.72	1.81	1.71
1968 summary:				
January–June	0.08	0.08	0.19	1.74
July–December	.00	.00	.00	1.74
January–December	.04	.04	.10	1.74
Highest weekly reading	.49	.46	1.36	3.50
Average undisturbed background (January–December)	1.74	1.97	1.82	1.77

[a] Due principally to argon-41 in reactor cooling air, and at the northeast perimeter, to the ecology forest cesium-137 source.

Table 2. Gross beta radioactivity in liquid waste effluent at BNL site boundary July-December 1968

1968	Volume of flow (gallons/day)	Average beta radioactivity concentration (pCi/liter)	Total beta radioactivity concentration discharged (mCi)	Tritium concentration (nCi/liter)	Tritium radioactivity (Ci)
July	885,000	14	1.4	2	0.2
August	968,000	15	1.6	8	.8
September	770,000	11	1.2	4	.4
October	885,000	10	.9	37	3.5
November	819,000	15	1.3	35	3.0
December	740,000	9	.9	14	1.2
January–June	896,000	18	10.8	14	8.5
July–December	839,000	13	7.3	16	9.1
January–December	866,000	15	18.1	15	17.6

Most gross beta measurement instruments are not sensitive to low energy beta emitters, such as tritium, for which special analysis methods must be employed. The concentration and amounts of tritium found during this reporting period in the laboratory's liquid waste effluent are also shown in table 2. The applicable AEC standard is 3 μCi/liter, averaged over a period of 1 year. The observed concentration of tritium at BNL was 0.5 percent of this standard.

Recent coverage in *Radiation Data and Reports:*

Period	Issue
January-June 1968	June 1972

Reported Nuclear Detonations, June 1972

(Includes seismic signals presumably from foreign nuclear detonations)

There were no nuclear detonations reported by the U.S. Atomic Energy Commission for June 1972 for the United States.

The U.S. Atomic Energy Commission announced that the United States recorded seismic signals, presumably from a Soviet underground nuclear explosion. The signals originated at about 9:30 p.m. (EDT), June 6, 1972, at the Semi-palatinsk nuclear test area and were equivalent to those of an underground nuclear explosion in the intermediate yield range of 20–200 kilotons.

Information in this section is based on data received during the month, and is subject to change as additional information may become available. Persons requiring information for purposes of compiling announced nuclear detonation statistics are advised to contact the Division of Public Information, U.S. Atomic Energy Commission, Washington, D.C. 20545.

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SYNOPSES

Synopses of reports, incorporating a list of key words, are furnished below in reference card format for the convenience of readers who may wish to clip them for their files.

RADIATION EXPOSURE TO STAFF CARDIOLOGIST VS SENIOR RESIDENT CARDIOLOGIST AND PATIENTS DURING CARDIAC CATHETERIZATION. *Stanley J. Malsky, Jacob Haft, David Hayt, Lawrence Gould, Charles Blatt, Donald F. Simon, and Bernard Roswit. Radiation Data and Reports*, Vol. 14, July 1972, pp. 387–391.

A study was conducted to compare the radiation exposure received by a senior resident cardiologist to that of the staff cardiologist when performing a full cardiac procedure. In addition, patient exposure values were obtained. The staff cardiologist was found to receive approximately 50–60 mR/procedure in the chest region and the senior resident received approximately 61 to 73 mR. The exposure to patients as calculated from tabletop measurements varied from 24 to 73 R.

KEYWORDS: Cardiac catheterization, diagnostic radiology, medical x rays, radiation exposure.

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RADIATION DATA AND REPORTS

Volume 13, Number 8, August 1972

Radiation Data and Reports, a monthly publication of the Environmental Protection Agency, presents data and reports provided by Federal, State, and foreign governmental agencies, and other cooperating organizations. Pertinent original data and interpretive manuscripts are invited from investigators.

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. This responsibility was delegated to the Bureau of Radiological Health, Public Health Service. Pursuant to the Reorganization Plan No. 3 of 1970, effective December 2, 1970, this responsibility was transferred to the Radiation Office of the Environmental Protection Agency which was established by this reorganization.

The Federal agencies listed below appoint their representatives to a Board of Editorial Advisors. Members of the Board advise on general publications policy; secure appropriate data and manuscripts from their agencies; and review those contents which relate to the special functions of their agencies.

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Environmental Protection Agency
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Published under the direction of

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U.S. ENVIRONMENTAL PROTECTION AGENCY
William D. Ruckelshaus, Administrator

SECTION I. MILK AND FOOD

Milk Surveillance, April 1972

Although milk is only one of the sources of dietary intake of environmental radioactivity, it is the food item that is most useful as an indicator of the general population's intake of radionuclide contaminants resulting from environmental releases. Fresh milk is consumed by a large segment of the population and contains several of the biologically important radionuclides that may be released to the environment from nuclear activities. In addition, milk is produced and consumed on a regular basis, is convenient to handle and analyze, and samples representative of general population consumption can be readily obtained. Therefore, milk sampling networks have been found to be an effective mechanism for obtaining information on current radionuclide concentrations and long-term trends. From such information, public health agencies can determine the need for further investigation or corrective public health action.

The Pasteurized Milk Network (PMN) sponsored by the Office of Radiation Programs, Environmental Protection Agency, and the Office of Food Sanitation, Food and Drug Administration, Public Health Service, consists of 63 sampling stations: 61 located in the United States, one in Puerto Rico, and one in the Canal Zone. Many of the State health departments also conduct local milk surveillance programs which provide more comprehensive coverage within the individual State. Data from 15 of these State networks are reported routinely in *Radiation Data and Reports*. Additional networks for the routine surveillance of radioactivity in milk in the Western Hemisphere and their sponsoring organizations are:

Pan American Milk Sampling Program (Pan American Health Organization and U.S. Environmental Protection Agency)—5 sampling stations

Canadian Milk Network (Radiation Protection Division, Canadian Department of National Health and Welfare)—16 sampling stations.

The sampling locations that make up the networks presently reporting in *Radiation Data and Reports* are shown in figure 1. Based on the similar purpose for these sampling activities, the present format integrates the complementary data that are routinely obtained by these several milk networks.

Radionuclide and element coverage

Considerable experience has established that relatively few of the many radionuclides that are formed as a result of nuclear fission become incorporated in milk (*1*). Most of the possible radiocontaminants are eliminated by the selective metabolism of the cow, which restricts gastrointestinal uptake and secretion into the milk. The five fission-product radionuclides which commonly occur in milk are strontium-89, strontium-90, iodine-131, cesium-137, and barium-140. A sixth radionuclide, potassium-40, occurs naturally in 0.0118 percent (*2*) abundance of the element potassium, resulting in a specific activity for potassium-40 of 830 pCi/g total potassium.

Two stable elements which are found in milk, calcium and potassium, have been used as a means for assessing the biological behavior

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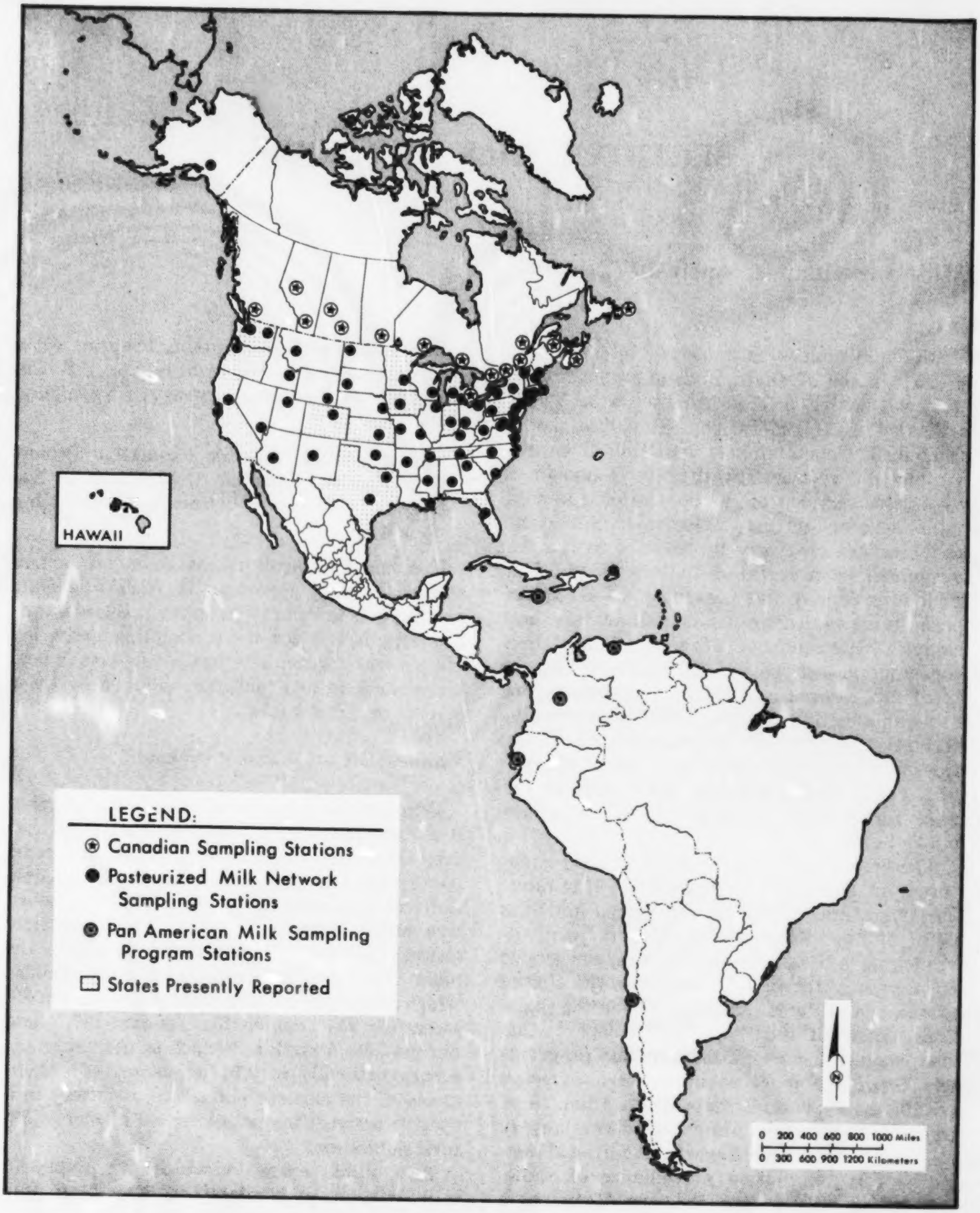
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LEGEND:
⊛ Canadian Sampling Stations
● Pasteurized Milk Network Sampling Stations
◉ Pan American Milk Sampling Program Stations
☐ States Presently Reported
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Figure 1. Milk sampling networks in the Western Hemisphere

of metabolically similar radionuclides (radiostrontium and radiocesium, respectively). The contents of both calcium and potassium in milk have been measured extensively and are relatively constant. Appropriate values and their variations, expressed in terms of 2 standard deviations (2σ), for these elements are 1.16 ± 0.08 g/liter for calcium and 1.51 ± 0.21 g/liter for potassium. These figures are averages of data from the PMN for May 1963–March 1966 (*3*) and are used for general radiation calculations.

Accuracy of data from various milk networks

In order to combine data from the international, national, and State networks considered in this report, it was first necessary to determine the accuracy with which each laboratory is making its determinations and the agreement of the measurements among the laboratories. The Analytical Quality Control Service of the Office of Radiation Programs conducts periodic studies to assess the accuracy of determinations of radionuclides in milk performed by interested radiochemical laboratories. The generalized procedure for making such a study has been outlined previously (*4*).

The most recent study was conducted during July 1971 with 37 laboratories participating in an experiment on a milk sample containing known concentrations of iodine-131, cesium-137, strontium-89, and strontium-90 (*5*). Of the 17 laboratories producing data for the networks reporting in *Radiation Data and Reports*, 14 participated in the study.

The accuracy results of this study for these 14 laboratories are shown in table 1. Considerable improvement has been made in the accuracy of the analyses of all radionuclides compared to the results of previous studies. Some improvement is still needed in the technique for determining the strontium-90 results. These possible differences should be kept in mind when considering the integration of data from the various networks.

Development of a common reporting basis

Since the various networks collect and analyze samples differently, a complete understanding of several parameters is useful for interpreting the data. Therefore, the various milk surveillance networks that report regularly were surveyed for information on analytical methods, sampling and analysis frequencies, and estimated analytical errors associated with the data.

In general, radiostrontium is collected by an ion-exchange technique and determined by beta-particle counting in low-background detectors, and the gamma-ray emitters (potassium-40, iodine-131, cesium-137, and barium-140) are determined by gamma-ray spectroscopy of whole milk. Each laboratory has its own modifications and refinements of these basic methodologies.

Many networks collect and analyze samples on a monthly basis. Some collect samples more frequently but composite the several samples for one analysis, while others carry out their analyses more often than once a month. Many networks are analyzing composite samples on a quarterly basis for certain nuclides. The frequency of collection and analysis varies not only among the networks but also at different

Table 1. Distribution of mean results, quality control experiment

Isotope and known concentration	Number of laboratories in each category				Experimental 2σ error (pCi/liter)
	Acceptable[a]	Warning level[b]	Unacceptable[c]	Total	
Iodine-131 (69 pCi/liter)	13 (100%)	0	0	13	6
Cesium-137 (52 pCi/liter)	12 (92%)	1 (8%)	0	13	6
Strontium-89 (31 pCi/liter)	9 (90%)	1 (10%)	0	10	6
Strontium-90 (41.6 pCi/liter)	9 (69%)	1 (8%)	3 (23%)	13	24

[a] Measured concentration equal to or within 2σ of the known concentration.
[b] Measured concentration outside 2σ and equal to or within 3σ of the known concentration.
[c] Measured concentration outside 3σ of the known concentration.

stations within some of the networks. In addition, the frequency of collection and analysis is a function of current environmental levels. The number of samples analyzed at a particular sampling station under current conditions is reflected in the data presentation. Current levels for strontium-90 and cesium-137 are relatively stable over short periods of time, and sampling frequency is not critical. For the short-lived radionuclides, particularly iodine-131, the frequency of analysis is critical and is generally increased at the first measurement or recognition of a new influx of this radionuclide.

The data in table 2 shows whether raw or pasteurized milk was collected. An analysis (*7*) of raw and pasteurized milk samples collected during January 1964 to June 1966 indicated that for relatively similar milkshed or sampling areas, the differences in concentration of radionuclides in raw and pasteurized milk are not statistically significant (*7*). Particular attention was paid to strontium-90 and cesium-137 in that analysis.

Practical reporting levels were developed by the participating networks, most often based on 2-standard-deviation counting errors or 2-standard-deviation total analytical errors from replicate analyses (*3*). The practical reporting level reflects analytical factors other than statistical radioactivity counting variations and will be used as a practical basis for reporting data.

The following practical reporting levels have been selected for use by all networks whose practical reporting levels were given as equal to or less than the given value.

Radionuclide	Practical reporting level (pCi/liter)
Strontium-89	5
Strontium-90	2
Iodine-131	10
Cesium-137	10
Barium-140	10

Some of the networks gave practical reporting levels greater than those above. In these cases, the larger value is used so that only data considered by the network as meaningful will be presented. The practical reporting levels apply to the handling of individual sample determinations. The treatment of measurements equal to or below these practical reporting levels for calculation purposes, particularly in calculating monthly averages, is discussed in the data presentation.

Analytical error or precision expressed as pCi/liter or percent in a given concentration range has also been reported by the networks (*3*). The precision errors reported for each of the radionuclides fall in the following ranges:

Radionuclide	Analytical errors of precision (2 standard deviations)
Strontium-89	1–5 pCi/liter for levels <50 pCi/liter; 5–10% for levels ≧50 pCi/liter;
Strontium-90	1–2 pCi/liter for levels <20 pCi/liter; 4–10% for levels ≧20 pCi/liter;
Iodine-131 Cesium-137 Barium-140	4–10 pCi/liter for levels <100 pCi/liter; 4–10% for levels ≧100 pCi/liter.

For iodine-131, cesium-137, and barium-140, there is one exception for these precision error ranges: 25 pCi/liter at levels <100 pCi/liter for Colorado. This is reflected in the practical reporting level for the Colorado milk network.

Federal Radiation Council guidance applicable to milk surveillance

In order to place the U.S. data on radioactivity in milk presented in *Radiation Data and Reports* in perspective, a summary of the guidance provided by the Federal Radiation Council for specific environmental conditions was presented in the December 1970 issue of *Radiological Health Data and Reports.*

Data reporting format

Table 2 presents the integrated results of the international, national, and State networks discussed earlier. Column 1 lists all the stations

Table 2. Concentrations of radionuclides in milk for April 1972 and 12-month period, May 1971 through April 1972

Sampling location		Type of sample[a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average[b]	12-month average	Monthly average[b]	12-month average
UNITED STATES:						
Ala:	Montgomery[c]	P	6	7	0	9
Alaska:	Palmer[c]	P	5	5	12	11
Ariz:	Phoenix[c]	P	0	0	0	0
Ark:	Little Rock[c]	P	12	12	0	12
Calif:	Sacramento[c]	P	3	1	0	0
	San Francisco[c]	P	0	3	0	0
	Del Norte	P	15	12	10	11
	Fresno	P	2	2	0	5
	Humboldt	P	6	4	0	7
	Los Angeles	P	0	2	0	4
	Mendocino	P	8	6	0	7
	Sacramento	P	3	2	0	5
	San Diego	P	0	1	0	4
	Santa Clara	P	2	1	0	7
	Shasta	P	4	3	0	7
	Sonoma	P	3	2	0	7
Colo:	Denver[c]	P	3	5	0	7
	East	R	(d)		[e]0 (2)	[e]0
	Northeast	R	(d)		[e]0 (2)	1
	Northwest	R	(d)		NS	[e]0
	South Central	R	(d)		NS	NS
	Southeast	R	(d)		[e]0	[e]0
	Southwest	R	(d)		[e]0	2
	West	R	(d)		NS	[e]0
Conn:	Hartford[c]	P	5	6	13	9
	Central	P	7	7	14	15
Del:	Wilmington[c]	P	8	8	12	4
D.C:	Washington[c]	P	5	7	0	7
Fla:	Tampa[c]	P	5	5	33	41
	Central	R	3	5	36	45
	North	R	3	10	19	24
	Northeast	R	8	7	30	34
	Southeast	R	5	6	28	55
	Tampa Bay area	P	3	5	32	39
	West	R	10	10	26	20
Ga:	Atlanta[c]	P	9	9	13	16
Hawaii:	Honolulu[c]	P	2	3	13	3
Idaho:	Idaho Falls[c]	P	5	5	0	1
Ill:	Chicago[c]	P	6	7	18	11
Ind:	Indianapolis[c]	P	7	7	0	4
	Central	P	10	7	10	13
	Northeast	P	10	7	20	15
	Northwest	P	9	8	20	15
	Southeast	P	9	8	10	15
	Southwest	P	10	8	15	16
Iowa:	Des Moines[c]	P	0	5	0	2
	Iowa City	P	7	6	0	10
	Des Moines	P	8	7	14	10
	Little Cedar	P	7	7	11	12
	Spencer	P	NS	6	NS	12
Kans:	Wichita[c]	P	6	8	0	2
	Coffeyville	P	7	8	0	13
	Dodge City	P	4	5	0	10
	Falls City, Nebr	R	0	5	NA	7
	Hays	P	NS	10	NS	6
	Kansas City	P	6	9	12	12
	Topeka	P	7	8	12	8
	Wichita	P	5	9	0	11
Ky:	Louisville[c]	P	8	8	12	8
La:	New Orleans[c]	P	14	14	15 (2)	15
Maine:	Portland[c]	P	5	7	27	20
Md:	Baltimore[c]	P	6	8	23	7
Mass:	Boston[c]	P	5	8	13	11
Mich:	Detroit[c]	P	8	7	14	10
	Grand Rapids[c]	P	7	8	14	10
	Bay City	P	5	6	14 (2)	15
	Charlevoix	P	NS	9	NS	15
	Detroit	P	2	6	15	11
	Grand Rapids	P	5	6	23	9
	Lansing	P	4	7	17	16
	Marquette	P	9	8	24	24
	Monroe	P	2	3	11	4
	South Haven	P	6	6	8	10
Minn:	Minneapolis[c]	P	7	8	17	16
	Bemidji	P	7	9	21	19
	Duluth	P	17	18	27	32
	Fergus Falls	P	6	8	16	18
	Little Falls	P	12	17	18	29
	Mankato	P	4	6	15	12
	Minneapolis	P	6	8	NS	17

See footnotes at end of table.

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Table 2. Concentrations of radionuclides in milk for April 1972 and 12-month period, May 1971 through April 1972 —continued

Sampling location		Type of sample[a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average[b]	12-month average	Monthly average[b]	12-month average
UNITED STATES:—continued						
Minn:	Rochester	P	6	8	12	14
	Worthington	P	NS	6	NS	12
Miss:	Jackson[c]	P	12	12	13	10
Mo:	Kansas City[c]	P	5	8	11	6
	St. Louis[c]	P	7	5	0	6
Mont:	Helena[c]	P	4	6	0	9
Nebr:	Omaha[c]	P	8	7	0	4
Nev:	Las Vegas[c]	P	0	2	0	1
N.H.:	Manchester[c]	P	7	8	13	18
N.J:	Trenton[c]	P	8	7	0	8
N. Mex:	Albuquerque[c]	P	3	3	0	0
N.Y:	Buffalo[c]	P	5	7	11	6
	New York City[c]	P	6	7	14	11
	Syracuse[c]	P	6	7	14	8
	Albany	P	6	6	[d]0 (3)	[d]0
	Buffalo	P	14	4	[d]0	[d]0
	Massena	P	NA		[d]0 (2)	[d]0
	New York City	P	5	7	14	[d]0
	Syracuse	P	NA		[d]0	[d]0
N.C:	Charlotte[c]	P	11	11	12	12
N. Dak:	Minot[c]	P	11	9	12	14
Ohio:	Cincinnati[c]	P	7	6	12	2
	Cleveland[c]	P	6	7	12	7
Okla:	Oklahoma City[c]	P	7	7	0	8
Oreg:	Portland[c]	P	6	5	0	5
	Baker	P	0	2	0	0
	Coos Bay	P	4	4	0	5
	Eugene	P	0	1	0	3
	Medford	P	0	1	21	6
	Portland composite	P	NA	4	0	10
	Portland local	P	NA	5	0	11
	Redmond	P	1	3	0	0
	Tillamook	P	0	4	17	15
Pa:	Philadelphia[c]	P	5	7	18	5
	Pittsburgh[c]	P	8	10	17	7
	Dauphin	P	4	6	17	11
	Erie	P	NS	8	NS	15
	Philadelphia	P	6	5	10	14
	Pittsburgh	P	7	7	25	15
R.I:	Providence[c]	P	6	8	11	12
S.C:	Charleston[c]	P	8	9	19	16
S. Dak:	Rapid City[c]	P	7	6	0	6
Tenn:	Chattanooga[c]	P	7	8	0	10
	Memphis[c]	P	6	7	0	6
	Chattanooga	P	10	10	10	13
	Clinton	R	NA	9	35	15
	Fayetteville	R	NA	10	23	7
	Kingston	R	NA	9	21	11
	Knoxville	P	NA	8	17 (2)	10
	Lawrenceburg	R	NS	8	NS	7
	Nashville	P	NA	8	16	6
	Pulaski	R	NA	8	24	6
Tex:	Austin[c]	P	0	1	0	0
	Dallas[c]	P	8	6	0	3
	Amarillo	R	NA		NA	
	Corpus Christi	R	NA		NA	
	El Paso	R	NA		NA	
	Fort Worth	R	NA		NA	
	Harlingen	R	NA		NA	
	Houston	R	NA		NA	
	Lubbock	R	NA		NA	
	Midland	R	NA		NA	
	San Antonio	R	NA		NA	
	Texarkana	R	NA		NA	
	Uvalde	R	NA		NA	
	Wichita Falls	R	NA		NA	
Utah:	Salt Lake City[c]	P	4	5	0	9
Vt:	Burlington[c]	P	4	5	15	12
Va:	Norfolk[c]	P	6	8	15	6
Wash:	Seattle[c]	P	0	4	0	6
	Spokane[c]	P	5	6	13	8
	Benten County	R	NS	1	NS	0
	Franklin County	R	3	1	0	4
	Sandpoint, Idaho	R	12	12	17	22
	Skagit County	R	8	8	0	8
W. Va:	Charleston[c]	P	8	8	14	6
Wisc:	Milwaukee[c]	P	5	6	0	5
Wyo:	Laramie[c]	P	4	3	0	2

See footnotes at end of table.

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Table 2. Concentration of radionuclides in milk for April 1972 and 12-month period, May 1972 through April 1972 —continued

Sampling location		Type of sample[a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average[b]	12-month average	Monthly average[b]	12-month average
CANADA:						
Alberta	Calgary	P	NA		17	20
	Edmonton	P	NA		23	24
British Columbia:	Vancouver	P	NA		19	26
Manitoba:	Winnipeg	P	NA		22	23
New Brunswick:	Fredericton	P	NA		17	21
Newfoundland:	St. John's	P	NA		19	32
Nova Scotia:	Halifax	P	NA		21	23
Ontario:	Ottawa	P	NA		8	13
	Sault Ste. Marie	P	NA		30	32
	Thunder Bay	P	NA		24	25
	Toronto	P	NA		8	13
	Windsor	P	NA		8	10
Quebec:	Montreal	P	NA		15	17
	Quebec	P	NA		27	28
Saskatchewan:	Regina	P	NA		16	17
	Saskatoon	P	NA		19	19
CENTRAL AND SOUTH AMERICA:						
Canal Zone:	Cristobal[c]	P	0	0	12	5
Chile:	Santiago	P	0	0	0	2
Colombia:	Bogota	P	0	1	0	0
Ecuador:	Guayaquil	P	0	0	0	0
Jamaica:	Kingston	P	3	4	24	63
Puerto Rico:	San Juan[c]	P	2	3	0	8
Venezuela:	Caracas	P	3	0	0	0
PMN network average[f]			6	7	10	8

[a] P, pasteurized milk.
R, raw milk.

[b] When an individual sampling result was equal to or less than the practical reporting level, a value of "0" was used for averaging. Monthly averages less than the practical reporting level reflect the fact that some but not all of the individual samples making up the average contained levels greater than the practical reporting level. When more than one analysis was made in a monthly period, the number of samples in the monthly average is given in parentheses.

[c] Pasteurized Milk Network station. All other sampling locations are part of the State or National network.

[d] Radionuclide analysis not routinely performed.

[e] The practical reporting levels for these networks differ from the general ones given in the text. Sampling results for the networks were equal to or less than the following practical reporting levels:

Iodine-131:		Cesium-137:		Strontium-90:
	Colorado—25 pCi/liter		Colorado—25 pCi/liter	New York—3 pCi/liter
	Michigan—14 pCi/liter		New York—20 pCi/liter	
	Oregon—15 pCi/liter		Oregon—15 pCi/liter	

[f] This entry gives the average radionuclide concentrations for the Pasteurized Milk Network stations denoted by footnote [c].
NA, no analysis.
NS, no sample collected.

which are routinely reported to *Radiation Data and Reports*. The relationship between the PMN stations and the State stations is shown in figure 2. The first column under each of the reported radionuclides gives the monthly average for the station and the number of samples analyzed in that month in parentheses. When an individual sampling result is equal to or below the practical reporting level for the radionuclide, a value of zero is used for averaging. Monthly averages are calculated using the above convention. Averages which are equal to or less than the practical reporting levels reflect the presence of radioactivity in some of the individual samples greater than the practical reporting level.

The second column under each of the radionuclides reported gives the 12-month average for the station as calculated from the preceding 12 monthly averages, giving each monthly average equal weight. Since the daily intake of radioactivity by exposed population groups, averaged over a year, constitutes an appropriate criterion for the case where the FRC radiation protection guides apply, the 12-month average serves as a basis for comparison.

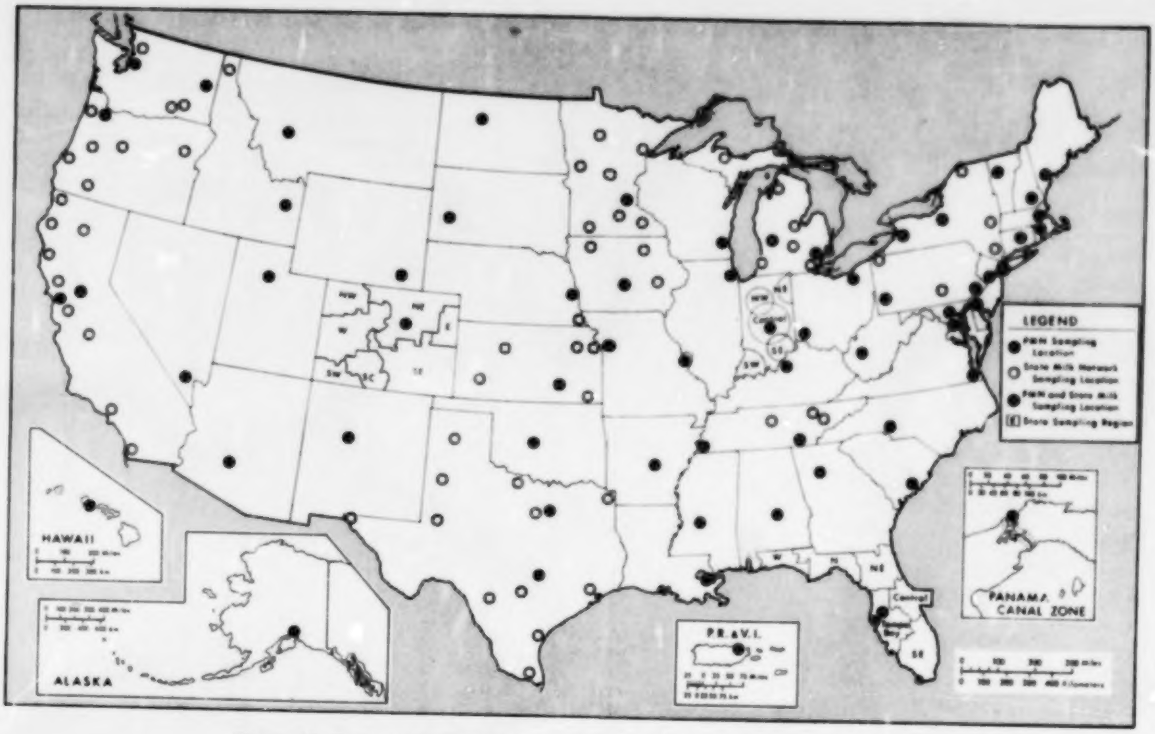

Figure 2. State and PMN milk sampling stations in the United States

Discussion of current data

In table 2, surveillance results are given for strontium-90 and cesium-137 for April 1972 and the 12-month period, May 1971 to April 1972. Except where noted, the monthly average represents a single sample for the sampling station. Strontium-89, iodine-131, and barium-140 data have been omitted from table 2 since levels at the great majority of the stations for April 1972 were below the respective practical reporting levels. Table 3 gives monthly averages for those stations at which strontium-89, iodine-131, and barium-140 were detected.

Strontium-90 monthly averages ranged from 0 to 17 pCi/liter in the United States for April 1972. The highest 12-month average was 18 pCi/liter (Duluth, Minn.) representing 9.0 percent of the Federal Radiation Council radiation

Table 3. Strontium-89, iodine-131 and barium-140 in milk, April 1972 [a]

Sampling location		Concentration (pCi/liter)		
		Strontium-89	Iodine-131	Barium-140
Calif:	Del Norte (State)	6		
	Humboldt (State)	5		
	Mendocino (State)	7		
Ga:	Atlanta (PMN)		19	
Kans:	Coffeyville (State)	6	10	
	Kansas City (State)	5	12	
	Topeka (State)		12	
	Wichita (State)	5		
Ky:	Louisville (PMN)		21	
La:	New Orleans (PMN)	12	51 (2)[b]	
Mich:	Monroe (State)			8
Miss:	Jackson (PMN)		21	
N.C:	Charlotte (PMN)		13	
S.C:	Charleston (PMN)			11
Tenn:	Chattanooga (PMN)		22	
	Chattanooga (State)		11	
	Clinton (State)		23	
	Knoxville (State)		7 (2)	
	Nashville (State)		90	
	Fayetteville (State)		71	
	Kingston (State)		38	
	Pulaski (State)		40	
C.Z:	Cristobal (PMN)		16	

[a] These levels of radioactivity are attributed to fallout from the March 18, 1972 nuclear detonation by the People's Republic of China.
[b] Number in parenthesis indicates number of samples.

protection guide. Cesium-137 monthly averages ranged from 0 to 36 pCi/liter in the United States for April 1972, and the highest 12-month average was 55 pCi/liter (Southeast Florida) representing 1.5 percent of the value derived from the recommendations given in the Federal Radiation Council report. Of particular interest are the consistently higher cesium-137 levels that have been observed in Florida (*8*) and Jamaica.

Acknowledgement

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Bureau of Radiological Health
Division of Environmental Sanitation
California State Department of Health

Radiation Protection Division
Canadian Department of National
Health and Welfare

Radiological Health Section
Division of Occupational and
Radiological Health
Colorado Department of Health

Radiological Health Services
Division of Medical Services
Connecticut State Department of Health

Radiological and Occupational
Health Section
Department of Health and
Rehabilitative Services
State of Florida

Bureau of Environmental Sanitation
Division of Sanitary Engineering
Indiana State Board of Health

Division of Radiological Health
Environmental Engineering Services
Iowa State Department of Health

Radiation Control Section
Environmental Health Division
Kansas State Department of Health

Radiological Health Services
Division of Occupational Health
Michigan Department of Health

Radiation Control Section
Division of Environmental Health
State of Minnesota Department of Health

Bureau of Radiological Pollution Control
New York State Department of
Environmental Conservation

Environmental Radiation Surveillance Program
Division of Sanitation and Engineering
Oregon State Board of Health

Radiological Health Section
Bureau of Environmental Health
Pennsylvania Department of Public Health

Radiological Health Services
Division of Preventable Diseases
Tennessee Department of Public Health

Division of Occupational Health
Environmental Health Services
Texas State Department of Health

Radiation Control Section
Division of Health
Washington Department of
Social and Health Services

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Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates, along with the guidance developed by the Federal Radiation Council, provides a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides. Programs reported in *Radiation Data and Reports* are as follows:

Program	Period reported	Issue
California Diet Study	July–December 1970	November 1971
Carbon-14 in Total Diet and Milk	July–December 1971	May 1972
Connecticut Standard Diet	January–December 1970	December 1971
Institutional Total Diet	October–December 1971 and 1971 Annual Summary	June 1972
Radiostrontium in Milk	January–December 1970	April 1972
Strontium-90 in Tri-City Diets	January–December 1970	November 1971

SECTION II. WATER

The Environmental Protection Agency and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2-4*), set the limits for approval of a drinking water supply containing radium-226 and strontium-90 at 3 pCi/liter and 10 pCi/liter, respectively. Higher concentrations may be acceptable if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence[1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities reported in *Radiation Data and Reports* are listed below.

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[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90, respectively.

Water sampling program	Period reported	Issue
Colorado River Basin	1968	March 1972
Interstate Carrier Drinking Water	1971	May 1972
Kansas	January–December 1970	December 1971
Michigan	January–June 1970	November 1971
North Carolina	January–December 1967	May 1969
Radioactivity in California Waters	January–December 1970	June 1972
Radioactivity in Florida Waters	1969	January 1972
Radiostrontium in Tap Water, *HASL*	January–June 1971	April 1972
Tritium in Community Water Supplies	1969	December 1970
Tritium Surveillance System	October–December 1971	May 1972
Washington	July 1969–June 1970	March 1972
New York	July–December 1970 and January–June 1971	May 1972

REFERENCES

(*1*) U.S. PUBLIC HEALTH SERVICE. Drinking water standards, revised 1962, PHS Publication No. 956. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (March 1963).

(*2*) FEDERAL RADIATION COUNCIL. Radiation Protection Guidance for Federal Agencies. Memorandum for the President, September 1961. Reprint from the Federal Register of September 26, 1961.

(*3*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 1. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (May 1960).

(*4*) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1961).

Gross Radioactivity in Surface Waters of the United States, December 1971

Office of Water Programs
U.S. Environmental Protection Agency

The monitoring of gross radioactivity in surface waters of the United States was initiated in 1957 as part of the Water Pollution Surveillance System (formerly National Water Quality Network) of the U.S. Public Health Service. Currently, the program is operated by the U.S. Environmental Protection Agency, Office of Water Programs. Regional offices of the Environmental Protection Agency are responsible for the collection of samples and the entering of the resulting data into the analytical storage and retrieval system. Radioactivity analyses are performed in the centralized radioactivity laboratories of the Office of Water Programs (Cincinnati, Ohio).

The regular reporting of gross radioactivity data in *Radiological Health Data and Reports* was terminated with the publication of data for October 1968 (April 1969 issue). With the publication of data for January 1971, this activity was resumed as a monthly report series. The unpublished data for the time interval of November 1968 through December 1970 will be the subject of a future summary article.

Table 1 presents the gross alpha and beta radioactivity results for samples collected from

Table 1. Gross radioactivity in U.S. surface waters, December 1971

River and station	Number of grab samples	Gross alpha radioactivity (pCi/liter)				Gross beta radioactivity (pCi/liter)			
		Suspended solids		Dissolved solids		Suspended solids		Dissolved solids	
Allegheny River:									
Pittsburgh, Pa	2	<0.4		<1		<1		3	(2, 3)
Animas River:									
Durango, Colo	1	<.3		<2		7		18	
Beaver River:									
New Brighton, Pa	1	2		<1		10		9	
Big Sandy River:									
Wayne County, Ky	1	<.3		1		<2		4	
Cheyenne River:									
Edgemont, S. Dak	1	1		10		6		20	
Clinch River:									
Kingston, Tenn	[a]4	<.3	(<.3, <.3)	<.5	(<.4, 0.7)	<1.2	(<1, 1.5)	8	(7,9)
Colorado River:									
Moab, Utah	[a]4	<1.5	(<.4, 4)	13	(4,24)	5	(2,10)	35	(12,69)
Above Moab, Utah	[a]4	<3	(<.4, 10)	11	(4, 22)	10	(4, 19)	32	(16,58)
DeBeque, Colo	1	<.4		8		<2		10	
Silt, Colo	1	<.3		13		2		8	
Detroit River:									
Detroit, Mich	1	<.3		<.4		<2		5	
Dolores River:									
Bedrock, Colo	[a]4	6	(2, 11)	5	(3, 8)	19	(14, 28)		(12, 22)
Gateway, Colo	[a]5	5	(1, 17)	25	(7, 57)	15	(3, 40)	60	(21, 79)
Gunnison River:									
Grand Junction, Colo	1	<.3		2		<2		14	
Guyandotte River:									
Guyandotte, W. Va	1	<.3		<.8		<2		8	
Kanawha River:									
Mason, W. Va	1	.5		<.4		<1		2	
Winfield Dam, W. Va	1	<.3		<1		<1		4	
Lake Erie:									
Buffalo, N.Y	1	.4		.7		2		6	
Maumee River:									
Toledo, Ohio	1	1		<1		3		6	
Mississippi River:									
Burlington, Iowa	1	<.3		1		<2		11	
Missouri River:									
St. Joseph, Mo	1	2		11		6		14	
St. Louis, Mo	1	2		4		6		14	
Yankton, S. Dak	1	<.4		4		<2		17	
Monongahela River:									
Pittsburgh, Pa	[a]2	<.4	(<.4, <.4)	.8	(.8, .8)	<1	(<1, <2)	5	(5, 5)
Muskingum River:									
Lock & Dam #2, Ohio	1	1		2		4		<5	
North Platte River:									
Henry, Nebr	1	1		24		4		42	

Footnote at end of table.

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Table 1. Gross radioactivity in U.S. surface waters. December 1971—continued

River and station	Number of grab samples	Gross alpha radioactivity (pCi/liter)				Gross beta radioactivity (pCi/liter)			
		Suspended solids		Dissolved solids		Suspended solids		Dissolved solids	
Ohio River:									
Addison, Ohio	1	<.4		1		<2		6	
Boyd County, Ky	1	<.4		1		2		4	
Cincinnati, Ohio	ᵃ5	<.5	(<.3, 1)	<.6	(<.5, <.7)	<4	(<2, 11)	7	(4, 14)
Gallipolis, Ohio	1	<.4		<.7		<2		4	
Hancock, W. Va	1	1		<1		3		5	
Kyger Creek, W. Va	1	<.3		<1		<2		4	
Marietta, Ohio	1	.6		<1		3		5	
New Martinsville, W. Va	1	<.4		<1		<2		7	
Old Lock #19, W. Va	1	<.3		<1		<2		6	
South Heights, Pa	1	<.3		<1		<2		5	
Warwood, W. Va	1	.6		<1		<2		5	
Potomac River:									
Williamsport, Md	1	.6		.6		<2		<2	
Roanoke River:									
John Kerr Dam, Va	ᵃ2	<.3	(<.3, <.3)	<.3	(<.3, <.3)	<2	(<2, <2)	3	(3, 4)
St. Lawrence River:									
Massena, N.Y	ᵃ3	<.3	(<.3, <.3)	<.6	(<.5, .7)	<2	(<2, <2)	6	(5, 7)
San Miguel River:									
Naturita, Colo	ᵃ5	<.6	(<.3, 2)	5	(2, 7)	<2	(<2, 3)	8	(4, 16)
Uravan, Colo	ᵃ5	<2	(<.3, 8)	12	(3, 30)	<6	(<2, 24)	14	(6, 22)
Below Uravan, Colo	ᵃ5	<2	(<.3, 4)	23	(8, 33)	11	(2, 28)	42	(14, 74)
Susquehanna River:									
Conowingo, Md	1	<.3		2		<2		4	

ᵃ Where more than one sample is analyzed during the month, the minimum and maximum are in parentheses.

25 rivers during December 1971. The analytical procedures used for determining gross alpha and beta radioactivity are described in the 13th Edition of *Standard Methods for the Examination of Water and Wastewater* (*1*). Results are reported for the date of counting and are not corrected to the date of collection. The sensitivity in counting is that defined by the National Bureau of Standards, Handbook 86 (*2*) and is calculated to be <0.2 pCi/liter for gross alpha radioactivity and <1 pCi/liter for gross beta radioactivity measurements.

REFERENCES

(*1*) AMERICAN PUBLIC HEALTH ASSOCIATION: AMERICAN WATER WORKS ASSOCIATION AND WATER POLLUTION CONTROL FEDERATION. Standard methods for the examination of water and wastewater, 13th edition, New York, N.Y. (1971).

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Tritium Surveillance System, January–March 1972

Office of Radiation Programs
Environmental Protection Agency

The Tritium Surveillance System is an expansion of previous tritum surveillance activities conducted by the Office of Radiation Programs, Environmental Protection Agency (EPA). The principal effort in the past by the Office of Radiation Programs related to tritium releases has been the Tritium in Surface Water Network. This network was established in 1964 to measure and monitor tritium concentrations in major river systems in the United States and to provide surveillance at surface water stations downstream from selected nuclear facilities. The network consisted of selected stations from existing water pollution sampling stations operated by the Office of Water Programs of EPA. The final data from this network for the period January–June 1970, have been published previously (*1*).

Another effort of the Office of Radiation Programs was a tritium in precipitation program. This project was established in 1967 at selected Radiation Alert Network (RAN) stations covering the United States, including Alaska and Hawaii. The RAN is operated by the Office of Air Programs of EPA. The data from this project for July–December 1969 have been published previously (*2*). Due to the increased interest in tritium releases from nuclear facilities and the potential long-term accumulation in the environment, a national system was established to incorporate these projects or networks into one overall system.

Present network

The Tritium Surveillance System consists of 70 quarterly drinking water samples at the RAN stations, precipitation samples collected daily and analyzed monthly from 8 of the RAN stations (figure 1), and quarterly samples at

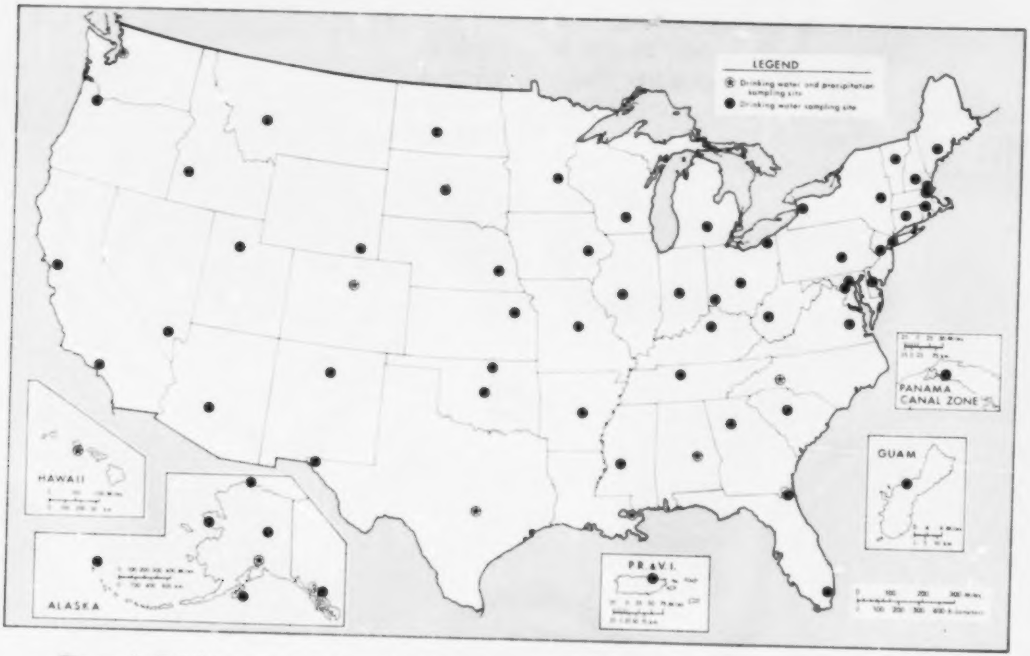
LEGEND
® Drinking water and precipitation sampling site
● Drinking water sampling site
HAWAII
ALASKA
PR & V.I.
PANAMA CANAL ZONE
GUAM

Figure 1. Drinking water and precipitation sampling locations for tritium surveillance system

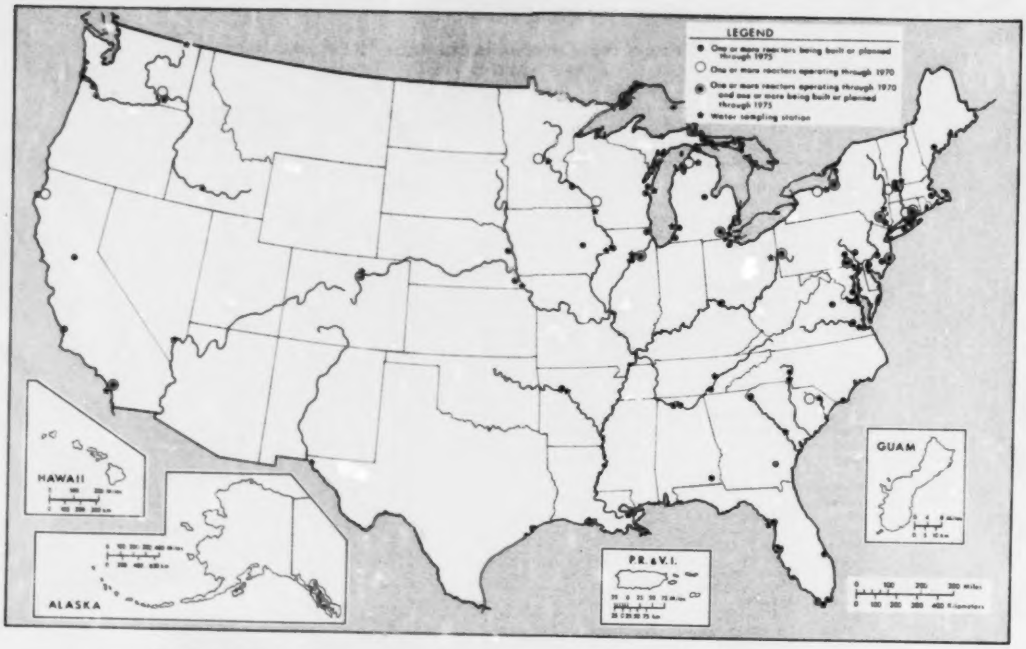
LEGEND
● One or more reactors being built or planned through 1975
○ One or more reactors operating through 1970
◉ One or more reactors operating through 1970 and one or more being built or planned through 1975
• Water sampling station
HAWAII
ALASKA
P.R. & V.I.
GUAM

Figure 2. Surface water sampling locations for tritium surveillance system

39 surface water stations (figure 2). The specific locations for the surface water sampling system were determined by examining the water drainage areas to assure that a representative sample from a large area or region was obtained, and if possible, incorporating several nuclear facility sites. All nuclear facilities that were operating, being constructed, or planned through 1975 were considered. Consideration was also given to the current surveillance programs of the States that will be involved in the collection of the samples. The surface water samples are collected quarterly either downstream from a nuclear facility or at a background station.

The tap water samples are collected by the RAN operators on a quarterly basis. The precipitation samples are also collected by the RAN operators on a daily basis.

All samples are sent to either the Eastern Environmental Radiation Laboratory or the Western Environmental Research Laboratory for analysis. Analytical values which are not statistically significant at the 2-sigma confidence level have been reported as zero.

Results and discussion

Table 1 presents the tritium concentrations in drinking water at the RAN stations for January–March 1972. The average tritium concentration was 0.3 nCi/liter.

The radiation dose resulting from the observed tritium concentrations in the drinking water may be evaluated by using the relationship derived by Moghissi and Porter (*3*) from recommendations of the International Commission on Radiological Units and Measurements (*4*). Assuming that the concentration of tritium in all water taken into the body is equal to that found in the drinking water and also that the specific activity of tritium in the body is essentially the same as that in the drinking water, then the radiation dose may be estimated.

The highest individual concentration of tritium observed in the drinking water was 1.2 nCi/liter during the first quarter. This corresponds to a dose of 0.2 mrem/a, or less than 0.2 percent of the Federal Radiation Council's Radiation Protection Guide (170 mrem/a) for

Table 1. Tritium concentration in tap water (RAN stations) January-March 1972

Location		Date collected (1972)	Tritium concentration[a] (nCi/liter)[b]
Ala:	Montgomery	1/4	0.2
Alaska:	Anchorage	1/4	.3
	Attu Island	1/10	0
	Fairbanks	1/24	1.2
	Juneau	1/1	.9
	Kodiak	NS	
	Nome	1/7	.6
	Point Barrow	1/1	.2
Ariz:	Phoenix	1/6	0
Ark:	Little Rock	1/7	.2
Calif:	Berkeley	1/3	0
	Los Angeles	1/4	0
C.Z:	Ancon	NS	
Colo:	Denver	1/7	1.1
Conn:	Hartford	1/10	.2
Del:	Dover	1/4	0
D.C:	Washington	1/18	.3
Fla:	Jacksonville	1/3	0
	Miami	1/3	0
Ga:	Atlanta	1/4	[illegible]
Guam:	Agana	1/3	0
Hawaii:	Honolulu	1/5	0
Idaho:	Boise	1/4	.5
Ill:	Springfield	1/3	.4
Ind:	Indianapolis	1/15	.3
Iowa:	Iowa City	1/3	.3
Kans:	Topeka	1/4	0
Ky:	Frankfort	1/11	.4
La:	New Orleans	1/10	.3
Maine:	Augusta	1/5	0
Md:	Baltimore	1/12	.4
Mass:	Lawrence	1/6	.3
	Winchester	1/10	.4
Mich:	Lansing	1/5	0
Minn:	Minneapolis	1/31	.8
Miss:	Jackson	1/4	0
Mo:	Jefferson City	1/4	0
Mont:	Helena	1/4	.6
Nebr:	Lincoln	1/3	0
Nev:	Las Vegas	1/4	1.0
N.H:	Concord	1/11	.5
N.J:	Trenton	1/5	.3
N. Mex:	Sante Fe	1/12	.3
N.Y:	Albany	1/11	.3
	Buffalo	1/5	.5
	New York	1/6	.4
N.C:	Gastonia	1/4	.3
N. Dak:	Bismark	1/11	1.0
Ohio:	Cincinnati	1/5	.3
	Columbus	1/3	.4
	Painesville	1/6	.4
Okla:	Oklahoma City	1/5	.3
	Ponca City	1/3	.3
Oreg:	Portland	1/28	0
Pa:	Harrisburg	1/17	.3
P.R:	San Juan	1/24	0
R.I:	Providence	1/13	.3
S.C:	Columbia	1/3	.3
S. Dak:	Pierre	1/3	1.2
Tenn:	Nashville	1/3	.3
Tex:	Austin	1/4	0
	El Paso	2/4	0
Utah:	Salt Lake City	1/19	.4
Vt:	Barre	1/7	0
Va:	Richmond	1/8	.3
Wash:	Seattle	1/11	.3
	Spokane	1/31	.2
W. Va:	Charleston	1/3	.3
Wisc:	Madison	1/6	.4
Wyo:	Cheyenne	NS	
Average			0.3

[a] The minimum detection limit for all samples was 0.20 nCi/liter. All values equal to or less than 0.20 nCi/liter before rounding have been reported as zero.

[b] The 2σ error for all samples is 0.2 nCi/liter unless otherwise noted.

NS, no sample.

an average dose to a suitable sample of the exposed population.

The tritium concentrations for the surface water samples are given in table 2. The highest tritium concentration was 4.7 nCi/liter for the first quarter. Assuming that the specific activity of tritium in the body is essentially the same as that in surface water, this concentra-

Table 2. Tritium concentration in surface water, January-March 1972

Location		Water source	Facility	Collection date (1972)	Concentration[a] (nCi/liter)[b]
Ala:	Decatur	Tennessee River	Browns Ferry	2/14	0.3
Ark:	Morrilton	Arkansas River	Arkansas Nuclear	1/5	.2
Calif:	Eureka	Humboldt Bay	Humboldt Bay	1/5	0
	San Onofre	Pacific Ocean	San Onofre	2/8	0
Colo:	Greely	South Platte River	Fort St. Vrain	1/10	1.3
Conn:	East Haddam	Connecticut River	Connecticut Yankee & Vermont Yankee	1/10	.4
	Waterford	Long Island Sound	Millstone	1/10	0
Fla:	Crystal River	Gulf of Mexico	Crystal River	1/20	0
	Homestead	Biscayne Bay	Turkey Point	1/11	0
Idaho:	Buhl	Snake River	National Reactor Testing Station	1/4	.4
Ill:	Moline	Mississippi River	Quad-Cities	1/19	.3
	Morris	Illinois River	Dresden and Argonne	1/13	.3
La:	New Orleans	Mississippi River	(Several)	1/4	.3
Md:	Conowingo	Susquehanna River	Peach Bottom and Three Mile Island	1/13	.4
	Lusby	Chesapeake Bay	Calvert Cliffs	1/19	0
Mass:	Rowe	Deerfield River	Yankee	1/31	.4
Mich:	Charlevoix	Lake Michigan	Big Rock Point	1/8	.3
	Monroe	Lake Erie	Enrico Fermi	1/18	.3
	South Haven	Lake Michigan	Palisades	1/8	.4
Minn:	Monticello	Mississippi River	Monticello	1/31	.9
Nebr:	Rulo	Missouri River	Fort Calhoun and Cooper	1/12	.8
Nev:	Boulder City	Colorado River	Background	1/13	1.2
N.J:	Bayside	Delaware River	Salem	1/25	0
N.Y:	Ossining	Hudson River	Indian Point	1/7	.6
	Oswego	Lake Ontario	Nine Mile Point and R. E. Ginna	1/11	.5
	Poughkeepsie	Hudson River	Background	1/12	.4
N.C:	Charlotte	Catawba River	Wm. B. McGuire	2/18	.4
Oreg:	Westport	Columbia River	Rainier and Hanford	1/1	.4
S.C:	Allendale	Savannah River	Savannah River Plant and Oconee	1/6	4.2
	Hartsville	Lake Robinson	H. B. Robinson	1/3	1.2
Tenn:	Kingston	Clinch River	Oak Ridge	1/10	4.7
Tex:	El Paso	Rio Grande	Los Alamos	2/4	.4
Vt:	Vernon	Connecticut River	Vermont Yankee	1/7	.3
Va:	Newport News	James River	Surry	[c]12/28/71	0
Wash:	Northport	Columbia River	Background	NS	
	Pasco	Columbia River	Hanford	1/7	.8
W. Va.:	Wheeling	Ohio River	Shippingport	1/5	.3
Wisc:	Two Creeks	Lake Michigan	Point Beach and Kewaunee	1/24	.4
	Victory	Mississippi River	LaCrosse and Prairie Island	1/17	.5
Average					0.6

[a] The minimum detection limit for all samples was 0.20 nCi/liter. All values equal to or less than 0.20 nCi/liter before rounding have been reported as zero.

[b] The 2σ error for all samples is 0.2 nCi/liter unless otherwise noted.

[c] Sample collected early.

NS, no sample.

tion corresponds to a dose of 0.8 mrem/a, or 0.5 percent of the Radiation Protection Guide.

The monthly analyses for tritium in precipitation samples at the eight RAN stations are shown in table 3.

Table 3. Tritium concentration in precipitation from RAN stations, January-March 1972

Location		Tritium concentration[a] (nCi/liter ± 2σ)		
		January	February	March
Ala:	Montgomery	0	0.3	0
Alaska:	Anchorage	NS	.3	.3
Colo:	Denver	0	.3	.6
Hawaii:	Honolulu	0	0	0
La:	New Orleans	NS	0	[illegible]
N.C:	Gastonia	0	0	.4
Tex:	Austin	0	NS	NS
Wash:	Seattle	0	0	0

[a] The minimum detection limit for these samples was 0.20 nCi/liter. All values equal to or less than 0.20 nCi/liter before rounding have been reported as zero. The 2σ error for all samples is 0.2 nCi/liter unless otherwise noted.

NS, No sample.

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(1) BUREAU OF RADIOLOGICAL HEALTH. Tritium in surface water network, January–June 1970. Radiol Health Data Rep 11:638–639 (November 1970).

(2) BUREAU OF RADIOLOGICAL HEALTH. Tritium in precipitation (RAN), July–December 1969. Radiol Health Data Rep 11:354–355 (July 1970).

(3) MOGHISSI, A. A. and C. R. PORTER. Tritium in surface waters in the United States, 1966. Radiol Health Data Rep 9:337–339 (July 1968).

(4) INTERNATIONAL COMMISSION ON RADIOLOGICAL UNITS AND MEASUREMENTS. Recommendations of the International Commission of Radiological Units and Measurements, National Bureau of Standards Handbook 85 (1964).

Other coverage in *Radiation Data and Reports:*

Period	Issue
January–March 1971	July 1971
April–June 1971	November 1971
July–September 1971	April 1972
October–December 1971	May 1972

SECTION III. AIR AND DEPOSITION

Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta radioanalysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the Environmental Protection Agency, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization.

In addition to those programs presented in this issue, the following programs were previously covered in *Radiation Data and Reports*.

Network	Period	Issue
Fallout in the United States and other areas, *HASL*	January–December 1970	December 1971
Mexican Air Monitoring Program	February–December 1971	May 1972
Plutonium in Airborne Particulates	October–December 1971	July 1972
Surface Air Sampling Program; 80th Meridian Network, *HASL*	January–December 1969	February 1972

1. Radiation Alert Network, April 1972

Division of Atmospheric Surveillance
Environmental Protection Agency

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Alert Network (RAN) which regularly gathers samples at 70 locations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

The station operators perform "field estimates" on the airborne particulate samples at 5 hours after collection, when most of the radon daughter products have decayed, and at 29 hours after collection, when most of the thoron daughter products have decayed. They also perform field estimates on dried precipitation samples and report all results to appropriate Environmental Protection Agency officials by mail or telephone depending on levels found. A compilation of the daily field estimates is available upon request from the Air Quality Information Systems Branch, Division of Atmospheric Surveillance, EPA, Research Triangle Park, N.C. 27711. A detailed description of the sampling and analytical procedures was presented in the March 1968 issue of *Radiological Health Data and Reports.*

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate technique, during April 1972.

Two stations reported high readings in precipitation for April: Nashville, Tenn.—65 nCi/m^2 on April 10; and Oklahoma City, Okla.—24 nCi/m^2 on April 27 and 21 nCi/m^2 on April 28, 1972.

All other field estimates reported were within normal limits for the reporting station.

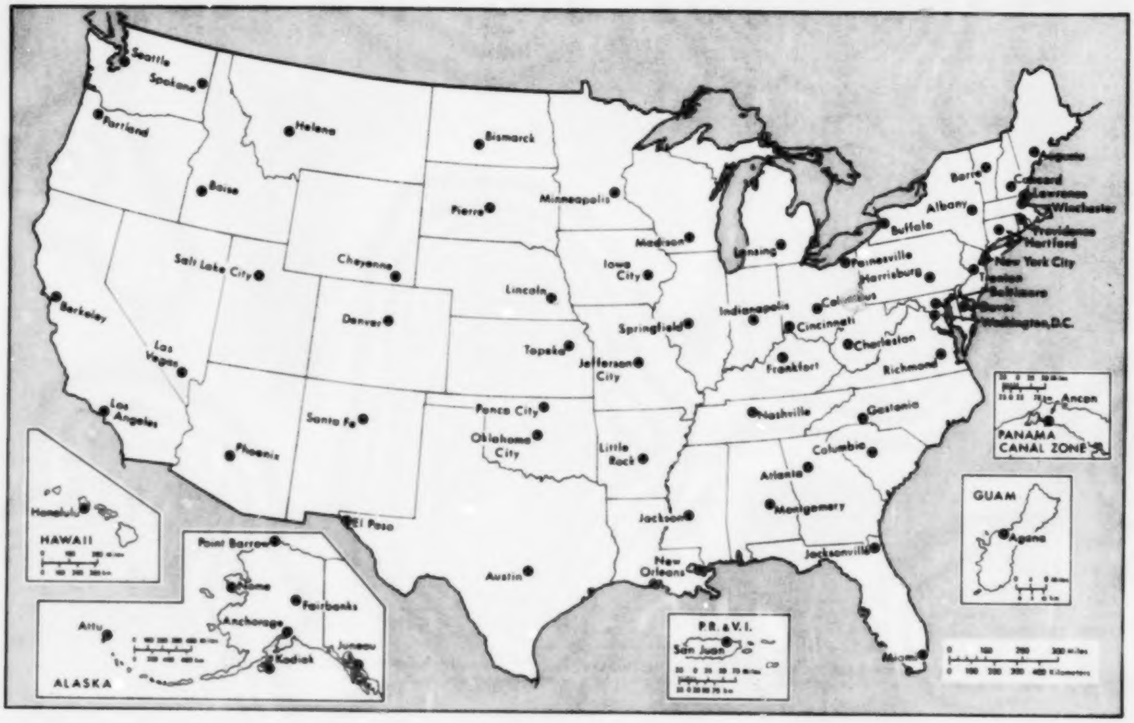
Seattle
Spokane
Portland
Helena
Bismarck
Boise
Pierre
Minneapolis
Salt Lake City
Cheyenne
Lincoln
Berkeley
Denver
Las Vegas
Topeka
Jefferson City
Los Angeles
Santa Fe
Ponca City
Oklahoma City
Phoenix
El Paso
Austin
Honolulu
HAWAII
Point Barrow
Nome
Fairbanks
Anchorage
Attu
Kodiak
Juneau
ALASKA
Madison
Iowa City
Springfield
Lansing
Indianapolis
Cincinnati
Columbus
Painesville
Harrisburg
Buffalo
Albany
Barre
Augusta
Concord
Lawrence
Winchester
Providence
Hartford
New York City
Trenton
Baltimore
Dover
Washington, D.C.
Charleston
Frankfort
Richmond
Nashville
Gastonia
Little Rock
Columbia
Atlanta
Montgomery
Jackson
New Orleans
Jacksonville
Miami
Ancon
PANAMA CANAL ZONE
GUAM
Agana
P.R. & V.I.
San Juan

Figure 1. Radiation Alert Network sampling stations

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Table 1. Gross beta radioactivity in surface air and precipitation, April 1972

Station location		Number of samples	Gross beta radioactivity (5-hour field estimate) (pCi/m³)			Precipitation				
						Number of samples	Total depth (mm)	Field estimation of deposition		
			Maximum	Minimum	Average[a]			Number of samples	Depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	18	3	1	1	2	33	2	33	3
Alaska:	Anchorage	3	0	0	0	0				
	Attu Island	0				0				
	Fairbanks	0				0				
	Juneau	17	1	0	0	6	60	6	60	17
	Kodiak	0				0				
	Nome	0				0				
	Point Barrow	0				0				
Ariz:	Phoenix	20	9	1	4	0				
Ark:	Little Rock	20	4	0	1	0				
Calif:	Berkeley	20	0	0	0	5	34	5	34	1
	Los Angeles	20	3	0	1	0				
C.Z:	Ancon	16	0	0	0	0				
Colo:	Denver	20	5	1	2	6	61	(b)		
Conn:	Hartford	19	1	0	0	9	83	9	83	1
Del:	Dover	20	1	0	0	0				
D.C:	Washington	23	2	0	0	0				
Fla:	Jacksonville	19	2	0	1	2	19	2	19	5
	Miami	20	1	0	0	2	56	2	56	0
Ga:	Atlanta	10	2	1	1	0				
Guam:	Agana	0				0				
Hawaii:	Honolulu	20	1	0	1	8	75	(b)		
Idaho:	Boise	0				0				
Ill:	Springfield	7	4	1	1	0				
Ind:	Indianapolis	20	1	0	0	0				
Iowa:	Iowa City	19	4	0	1	3	120	3	120	0
Kans:	Topeka	20	6	1	2	8	64	8	64	8
Ky:	Frankfort	0				0				
La:	New Orleans	16	0	0	0	3	23	(b)		
Maine:	Augusta	8	1	0	0	4	51	4	51	0
Md:	Baltimore	20	2	0	0	5	45	5	45	0
Mass:	Lawrence	18	1	0	0	7	79	7	79	0
	Winchester	19	2	0	1	9	92	9	92	0
Mich:	Lansing	20	1	0	0	7	98	7	98	9
Minn:	Minneapolis	19	1	0	0	3	29	3	29	7
Miss:	Jackson	15	1	0	1	2	25	2	25	13
Mo:	Jefferson City	19	3	1	1	9	100	9	100	2
Mont:	Helena	20	3	0	1	2	7	2	7	0
Nebr:	Lincoln	17	8	1	3	1	2	1	2	0
Nev:	Las Vegas	20	3	0	1	0				
N.H:	Concord	0				0				
N.J:	Trenton	20	2	0	0	9	81	9	81	13
N. Mex:	Santa Fe	19	3	0	1	0				
N.Y:	Albany	12	0	0	0	0				
	Buffalo	18	3	0	0	0				
	New York City	0				0				
N.C:	Gastonia	18	10	1	2	2	19	(b)		
N. Dak:	Bismarck	19	3	0	1	4	49	4	49	3
Ohio:	Cincinnati	0				0				
	Columbus	4	1	0	1	0				
	Painesville	19	1	0	0	8	100	8	100	31
Okla:	Oklahoma City	5	3	1	1	3	65	3	65	54
	Ponca City	19	5	1	2	5	41	5	41	0
Oreg:	Portland	19	1	0	0	13	99	13	99	11
Pa:	Harrisburg	12	1	0	0	2	24	2	24	4
P.R:	San Juan	0				0				
R.I:	Providence	20	1	0	0	0				
S.C:	Columbia	15	4	0	1	2	43	2	43	0
S. Dak:	Pierre	19	3	0	2	0				
Tenn:	Nashville	19	2	0	1	6	71	6	71	74
Tex:	Austin	15	8	2	3	1	14	(b)		
	El Paso	7	3	1	1	0				
Utah:	Salt Lake City	30	2	0	1	9	64	9	64	29
Vt:	Barre	20	2	0	1	8	58	8	58	7
Va:	Richmond	18	1	0	0	1	2	1	2	0
Wash:	Seattle	8	0	0	0	7	90	(b)		
	Spokane	20	2	0	1	0				
W. Va:	Charleston	19	2	0	1	11	117	11	117	15
Wisc:	Madison	19	1	0	0	4	66	4	66	5
Wyo:	Cheyenne	20	6	1	2	1	2	1	2	3
Network summary		995	10	0	1	194	65	5	57	10

[a] The monthly average is calculated by weighting the field estimates of individual air samples with length of sampling period.
[b] This station is part of the tritium surveillance system. No gross beta measurements are done.

2. Canadian Air and Precipitation Monitoring Program,[1] April 1972

Radiation Protection Division
Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 2), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*1–5*).

A summary of the sampling procedures and methods of analysis was presented in the May 1969 issue of *Radiological Health Data and Reports.*

Surface air and precipitation data for April 1972 are presented in table 2.

Table 2. Canadian gross beta radioactivity in surface air and precipitation, April 1972

Station	Number of samples	Air surveillance gross beta radioactivity (pCi/m³)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentration (pCi/liter)	Total deposition (nCi/m²)
Calgary	10	0.5	0.1	0.1	39	0.6
Coral Harbour	9	.1	.0	.1	58	1.1
Edmonton	9	.3	.1	.1	20	.8
Ft. Churchill	9	.1	.0	.1	45	.7
Fredericton	9	.2	.1	.1	286	13.0
Goose Bay	9	.1	.1	.1	51	2.8
Halifax	9	.3	.1	.2	80	9.5
Inuvik	4	.1	.0	.1	29	.8
Montreal	9	.1	.0	.0	44	2.6
Moosonee	9	.1	.0	.1	117	.9
Ottawa	9	.1	.0	.1	125	5.7
Quebec	9	.2	.0	.1	123	5.1
Regina	9	.2	.0	.1	101	2.5
Resolute	9	.1	.1	.1	NS	
St. John's, Nfld	8	.1	.1	.1	13	1.4
Saskatoon	9	.1	.1	.1	125	1.0
Sault Ste. Marie	9	.1	.0	.1	221	17.5
Thunder Bay	10	.1	.0	.1	101	2.8
Toronto	8	.1	.0	.0	107	6.3
Vancouver	9	.2	.0	.1	28	3.3
Whitehorse	9	.1	.0	.0	24	.4
Windsor	9	.3	.0	.1	35	3.8
Winnipeg	8	.1	.1	.1	550	7.1
Yellowknife	11	.2	.0	.1	264	4.0
Network summary	212	0.5	0.0	0.1	112	4.1

NS, no sample.

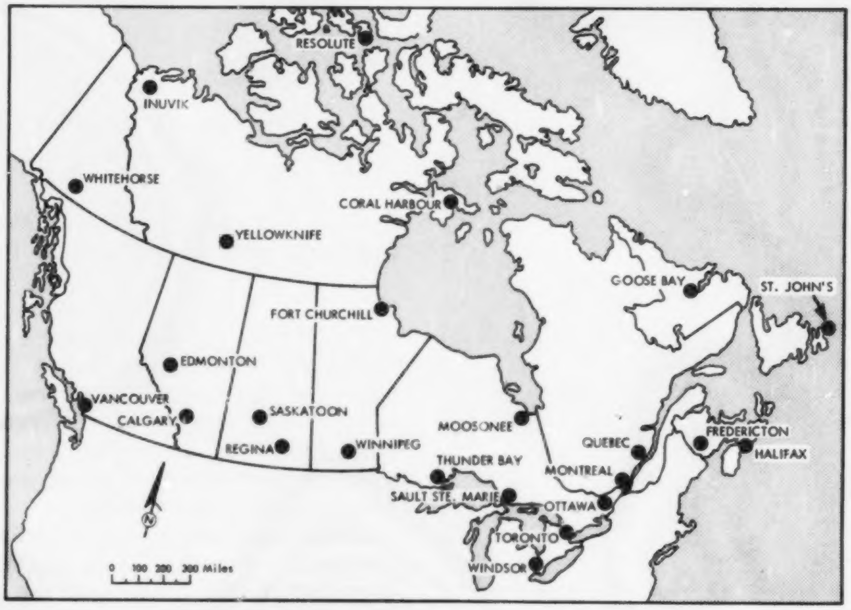
RESOLUTE
INUVIK
WHITEHORSE
CORAL HARBOUR
YELLOWKNIFE
GOOSE BAY
ST. JOHN'S
FORT CHURCHILL
EDMONTON
VANCOUVER
CALGARY
SASKATOON
MOOSONEE
FREDERICTON
HALIFAX
QUEBEC
REGINA
WINNIPEG
THUNDER BAY
MONTREAL
SAULT STE. MARIE
OTTAWA
TORONTO
WINDSOR
N
0 100 200 300 Miles

Figure 2. Canadian air and precipitation sampling stations

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[1] Prepared from information and data obtained from the Canadian Department of National Health and Welfare, Ottawa, Canada.

3. Pan American Air Sampling Program
April 1972

Pan American Health Organization and
U.S. Environmental Protection Agency

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the Environmental Protection Agency (EPA) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 3. Analytical techniques were described in the March 1968 issue of *Radiological Health Data and Reports*. The April 1972 air monitoring results from the participating countries are given in table 3.

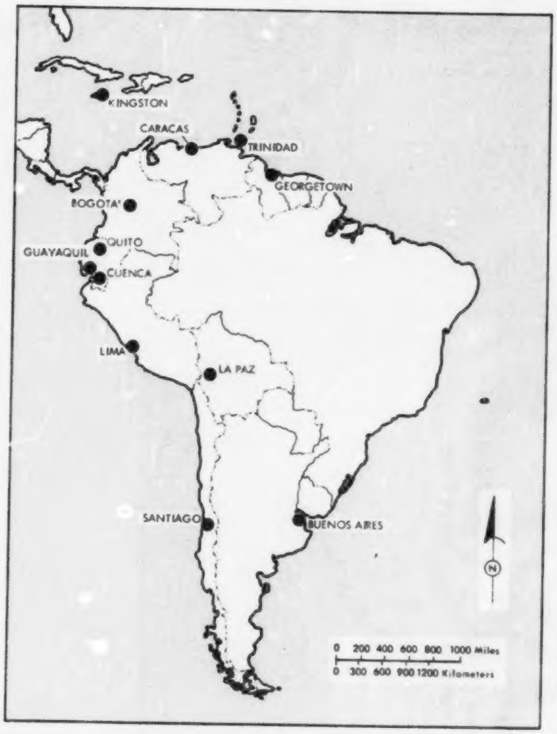

Figure 3. Pan American Air Sampling Program stations

Table 3. Summary of gross beta radioactivity in Pan American surface air, April 1972

Station location		Number of samples	Gross beta radioactivity (pCi/m³)		
			Maximum	Minimum	Average[a]
Argentina:	Buenos Aires	0			
Bolivia:	La Paz	5	0.03	0.01	0.02
Chile:	Santiago	28	.20	.04	.09
Colombia:	Bogota	20	.05	.00	.01
Ecuador:	Cuenca	1	.01	.01	.01
	Guayaquil	6	.06	.02	.04
	Quito	9	.01	.00	.00
Guyana:	Georgetown	0			
Jamaica:	Kingston	0			
Peru:	Lima	0			
Venezuela:	Caracas	16	.18	.00	.05
West Indies:	Trinidad	16	.57	.03	.15
Pan American summary		101	0.57	0.00	0.06

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values less than 0.005 pCi/m³ are reported and used in averaging as 0.00 pCi/m³.

4. California Air Sampling Program
April 1972

Bureau of Radiological Health
California State Department of Public Health

The Bureau of Radiological Health of the California State Department of Public Health with the assistance of several cooperating agencies and organizations operates a surveillance system for determining radioactivity in airborne particulates. The air sampling locations are shown in figure 4.

All air samples are sent to the Sanitation and Radiation Laboratory of the State Department of Public Health where they are analyzed for their radioactive content.

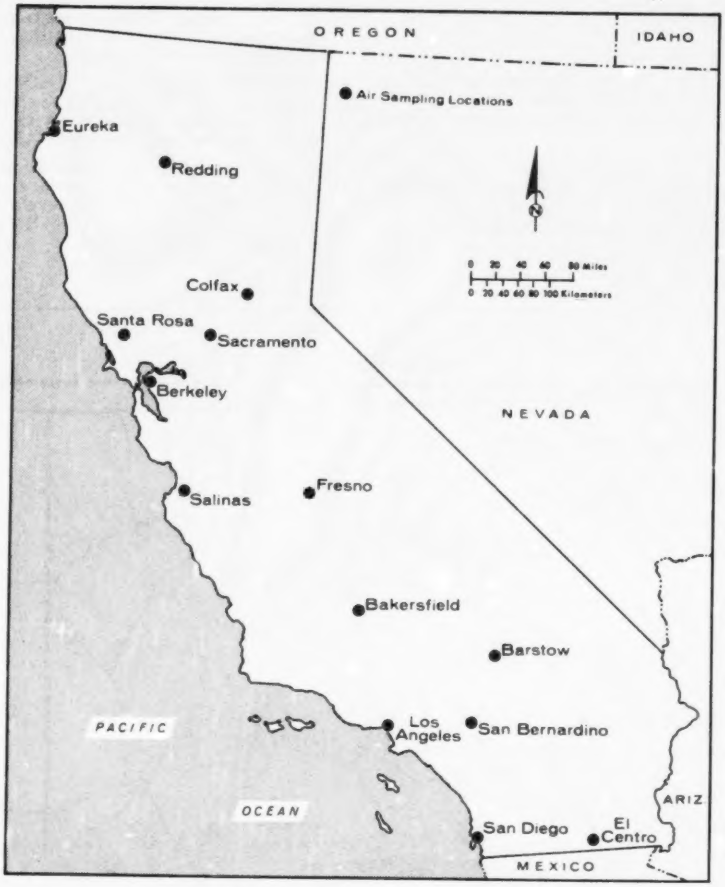
OREGON
IDAHO
Air Sampling Locations
N
0 20 40 60 80 Miles
0 20 40 60 80 100 Kilometers
Eureka
Redding
Colfax
Santa Rosa
Sacramento
Berkeley
NEVADA
Salinas
Fresno
Bakersfield
Barstow
PACIFIC
Los Angeles
San Bernardino
OCEAN
ARIZ
San Diego
El Centro
MEXICO

Figure 4. California Air Sampling Program stations

Airborne particles are collected by a continuous sampling of air filtered through a 47 millimeter membrane filter, 0.8 micron pore size, using a Gast air pump of about 2 cubic feet per minute capacity, or 81.5 cubic meters per day. Air volumes are measured with a direct-reading gas meter. Filters are replaced every 24 hours except on holidays and weekends. The filters are analyzed for gross alpha and beta radioactivity. Analyses are normally made 72 hours after the end of the collection period. The daily samples are then composited into a monthly sample. A monthly gamma-scan and analysis for strontium-89 and strontium-90 are presented quarterly. Table 4 presents the monthly gross beta radioactivity in air for April 1972.

Table 4. Gross beta radioactivity in California air April 1972

Station location	Number of samples	Gross beta radioactivity (pCi/m^3)		
		Maximum	Minimum	Average
Bakersfield	28	2.27	0.08	0.59
Barstow	29	4.04	.09	.62
Berkeley	29	1.90	.00	.19
Colfax	30	7.74	.05	.59
El Centro	26	2.85	.13	.68
Eureka	28	.91	.00	.19
Fresno	30	1.54	.13	.37
Los Angeles	28	.56	.00	.18
Redding	25	10.80	.08	.64
Sacramento	25	.47	.00	.19
Salinas	28	2.66	.03	.42
San Bernardino	28	1.20	.09	.44
San Diego	30	1.13	.07	.31
Santa Rosa	30	1.67	.02	.24
Summary	394	10.80	0.00	0.40

REFERENCES

(*1*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report of 1959 on the Radioactive Fallout Study Program, CNHW-RP-3. Department of National Health and Welfare, Ottawa, Canada (May 1960).

(*2*) BIRD, P. M., A. H. BOOTH, and P. G. MAR. Annual report for 1960 on the Radioactive Fallout Study Program, CNHW-RP-4. Department of National Health and Welfare, Ottawa, Canada (December 1961).

(*3*) MAR, P. G. Annual report for 1961 on the Radioactive Fallout Study Program, CNHW-RP-5. Department of National Health and Welfare, Ottawa, Canada (December 1962).

(*4*) BEALE, J. and J. GORDON. The operation of the Radiation Protection Division Air Monitoring Program, RPD-11. Department of National Health and Welfare, Ottawa, Canada (July 1962).

(*5*) BOOTH, A. H. The calculation of permissible levels of fallout in air and water and their use in assessing the significance of 1961 levels in Canada, RPD-21. Department of National Health and Welfare, Ottawa, Canada (August 1962).

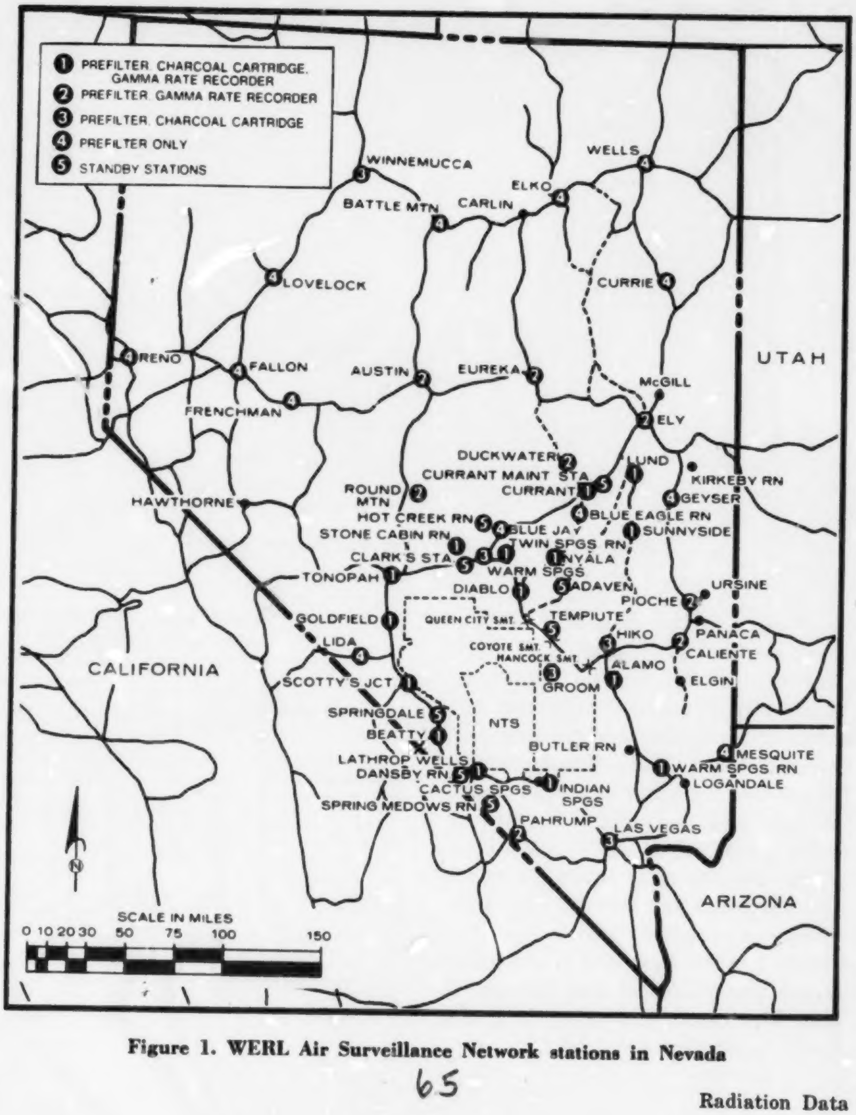
① PREFILTER. CHARCOAL CARTRIDGE, GAMMA RATE RECORDER
② PREFILTER. GAMMA RATE RECORDER
③ PREFILTER. CHARCOAL CARTRIDGE
④ PREFILTER ONLY
⑤ STANDBY STATIONS
WINNEMUCCA
WELLS
ELKO
BATTLE MTN
CARLIN
LOVELOCK
CURRIE
RENO
FALLON
AUSTIN
EUREKA
UTAH
McGILL
FRENCHMAN
ELY
DUCKWATER
LUND
CURRANT MAINT STA
KIRKEBY RN
ROUND MTN
CURRANT
GEYSER
HAWTHORNE
HOT CREEK RN
BLUE EAGLE RN
BLUE JAY
SUNNYSIDE
STONE CABIN RN
TWIN SPGS RN
CLARK'S STA
NYALA
WARM SPGS
TONOPAH
DIABLO
ADAVEN
URSINE
PIOCHE
GOLDFIELD
QUEEN CITY SMT.
TEMPIUTE
HIKO
PANACA
LIDA
COYOTE SMT.
HANCOCK SMT.
CALIENTE
ALAMO
CALIFORNIA
SCOTTY'S JCT
GROOM
ELGIN
SPRINGDALE
NTS
BEATTY
BUTLER RN
MESQUITE
LATHROP WELLS
WARM SPGS RN
DANSBY RN
LOGANDALE
CACTUS SPGS
INDIAN SPGS
SPRING MEDOWS RN
PAHRUMP
LAS VEGAS
N
ARIZONA
SCALE IN MILES
0 10 20 30 50 75 100 150

Figure 1. WERL Air Surveillance Network stations in Nevada

Air Surveillance Network, April 1972

Western Environmental Research Laboratory
Environmental Protection Agency

The Air Surveillance Network (ASN), operated by the Western Environmental Research Laboratory (WERL), consists of 104 active and 18 standby sampling stations located in 21 western States (figures 1 and 2). The network is operated in support of nuclear testing sponsored by the Atomic Energy Commission (AEC) at the Nevada Test Site (NTS), by the Space Nuclear Systems Office at the Nuclear Rocket Development Station which lies within the NTS, and by the AEC at any other designated testing sites.[1]

The stations are operated by State health department personnel and by private individuals on a contract basis. Daily 24-hour samples are collected at each station. All samples are mailed to the WERL unless special retrieval is arranged at selected locations in support of known releases of radioactivity from the NTS. A complete description of sampling and analytical procedures was presented in the February 1972 issue of *Radiation Data and Reports.*

Results

Table 1 presents the monthly average gross beta radioactivity in air particulates for each of the network stations. The minimum reported concentration for gross beta is 0.1 pCi/m^3; however, gross beta concentrations above the minimum detectable concentration of 0.06 pCi/m^3 are used in determining averages. Individual concentrations which are below the minimum detectable concentration are assumed to be equal to the minimum detectable concentration. Averages less than the minimum reported level are reported as <0.1 pCi/m^3. The highest gross

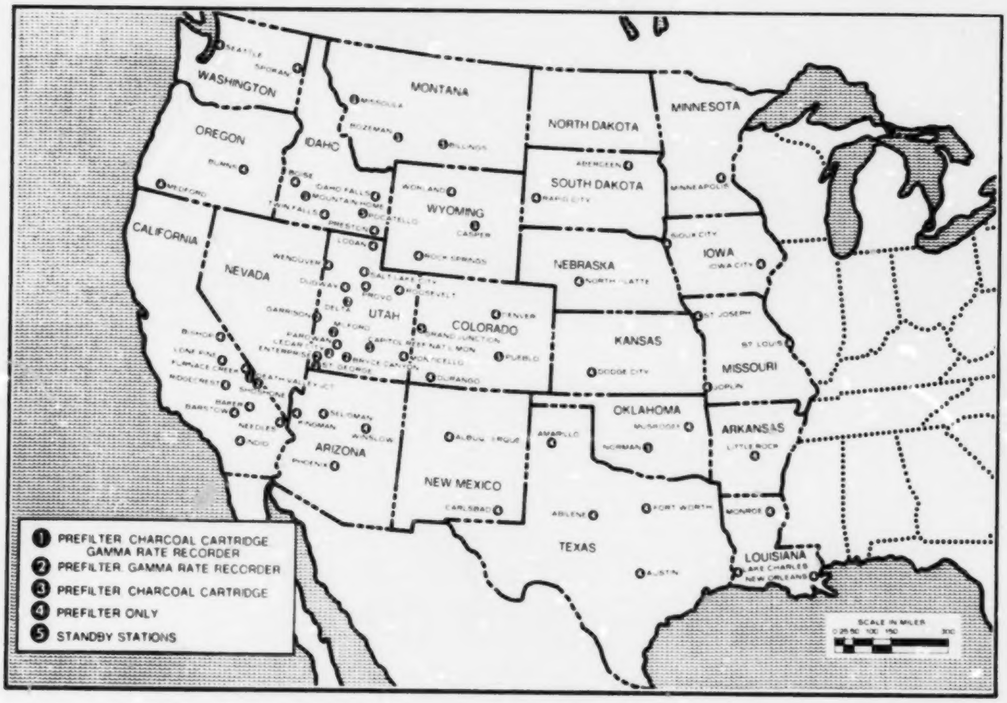
WASHINGTON
OREGON
CALIFORNIA
NEVADA
IDAHO
MONTANA
WYOMING
UTAH
COLORADO
ARIZONA
NEW MEXICO
NORTH DAKOTA
SOUTH DAKOTA
NEBRASKA
KANSAS
OKLAHOMA
TEXAS
MINNESOTA
IOWA
MISSOURI
ARKANSAS
LOUISIANA
❶ PREFILTER CHARCOAL CARTRIDGE GAMMA RATE RECORDER
❷ PREFILTER GAMMA RATE RECORDER
❸ PREFILTER CHARCOAL CARTRIDGE
❹ PREFILTER ONLY
❺ STANDBY STATIONS
SCALE IN MILES

Figure 2. WERL Air Surveillance Network stations outside Nevada

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[1] The ASN is operated under a Memorandum of Understanding (No. AT(26-1)-539) with the Nevada Operations Office, U.S. Atomic Energy Commission.

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Table 1. Summary of gross beta radioactivity concentrations in air, April 1972

Location		Number of samples	Concentration (pCi/m³)		
			Maximum	Minimum	Average[a]
Ariz:	Kingman	30	4.9	0.1	1.0
	Phoenix	30	2.4	.1	.9
	Seligman	30	3.5	<.1	.7
	Winslow	30	5.9	<.1	1.0
Ark:	Little Rock	19	1.8	.1	.3
Calif:	Baker	30	1.5	.1	.4
	Barstow	30	4.1	<.1	.8
	Bishop	30	3.7	.1	.7
	Death Valley Junction	30	2.8	<.1	.7
	Furnace Creek	30	2.4	<.1	.8
	Indio	30	3.8	<.1	.6
	Lone Pine	26	1.8	.1	.6
	Needles	24	2.8	.1	.8
	Ridgecrest	30	2.0	.1	.5
	Shoshone	30	1.7	<.1	.6
Colo:	Denver	20	6.5	<.1	.8
	Durango	29	3.8	.1	.7
Idaho:	Boise	30	3.7	<.1	.5
	Idaho Falls	20	1.7	<.1	.5
	Preston	29	6.0	.1	.6
	Twin Falls	30	4.0	<.1	.6
Iowa:	Iowa City	20	.4	.1	.1
	Sioux City	24	.3	<.1	.2
Kans:	Dodge City	30	.9	<.1	.2
La:	Lake Charles	19	.7	<.1	.3
	Monroe	22	1.8	<.1	.3
	New Orleans	16	2.2	.1	.4
Minn:	Minneapolis	19	.6	<.1	.2
Mo:	Joplin	30	1.9	<.1	.3
	St. Joseph	30	2.4	<.1	.3
	St. Louis	29	2.7	.1	.3
Nebr:	North Platte	24	1.7	<.1	.3
Nev:	Alamo	28	3.0	<.1	.7
	Austin	25	2.3	.1	.7
	Battle Mountain	30	2.2	<.1	.5
	Beatty	30	1.7	<.1	.5
	Blue Eagle Ranch (Currant)	27	1.1	<.1	.5
	Blue Jay	30	3.5	<.1	.6
	Caliente	29	4.4	<.1	.9
	Currant Ranch	30	1.7	.1	.6
	Currie	30	1.4	<.1	.5
	Diablo	30	2.3	<.1	.6
	Duckwater	23	3.5	<.1	.7
	Elko	29	5.0	<.1	.7
	Ely	29	1.4	<.1	.4
	Eureka	30	5.1	<.1	.9
	Fallini's Twin Springs Ranch	30	1.2	<.1	.5
	Fallon	30	4.8	.1	.6
	Frenchman Station	30	2.6	<.1	.5
	Geyser Maintenance Station	28	3.6	<.1	.7
	Goldfield	17	1.2	<.1	.5
	Groom Lake	28	2.4	.1	.8
	Hiko	30	3.7	<.1	.7
	Indian Springs	30	4.9	<.1	.7
	Las Vegas	20	3.7	.1	.9
	Lathrop Wells	27	4.0	<.1	.8
	Lida	30	2.1	<.1	.5
	Lovelock	30	3.3	<.1	.7
	Lund	30	5.8	<.1	.8
	Mesquite	30	2.1	<.1	.6
	Nyala	20	1.2	<.1	.5
	Pahrump	20	1.7	<.1	.5
	Pioche	30	4.9	<.1	.9
	Reno	30	2.4	<.1	.4
	Round Mountain	30	2.9	<.1	.7
	Scotty's Junction	27	1.4	<.1	.6
	Stone Cabin Ranch	30	1.7	<.1	.5
	Sunnyside	24	1.9	.1	.7
	Tonopah	30	1.1	<.1	.5
	Tonopah Test Range	25	1.7	<.1	.5
	Warm Springs Ranch	30	1.8	<.1	.6
	Wells	30	2.1	<.1	.6
	Winnemucca	30	1.8	<.1	.4
N. Mex:	Albuquerque	19	4.3	<.1	1.2
	Carlsbad	27	7.7	.1	1.1
Okla:	Muskogee	30	1.0	<.1	.2
Oreg:	Burns	30	3.2	<.1	.4
	Medford	25	.6	<.1	.2
S. Dak:	Aberdeen	18	.7	<.1	.2
	Rapid City	28	.8	<.1	.2
Tex:	Abilene	26	1.3	<.1	.3
	Amarillo	30	2.5	<.1	.5
	Austin	15	.9	<.1	.3
	Fort Worth	30	1.5	<.1	.5

See footnote at end of table.

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Table 1. Summary of gross beta radioactivity concentrations in air, April 1972—continued

Location		Number of samples	Concentration (pCi/m³)		
			Maximum	Minimum	Average[a]
Utah:	Bryce Canyon	22	3.2	<.1	.7
	Cedar City	29	2.4	<.1	.7
	Delta	30	4.2	<.1	.8
	Dugway	28	1.6	<.1	.5
	Enterprise	30	2.3	<.1	.6
	Garrison	30	.6	<.1	.3
	Logan	30	3.3	<.1	.6
	Milford	30	3.8	<.1	.7
	Monticello	30	2.6	<.1	.7
	Parowan	30	7.4	<.1	.9
	Provo	29	2.7	<.1	.6
	Roosevelt	30	2.9	<.1	.7
	Salt Lake City	30	3.4	<.1	.5
	St. George	30	3.4	<.1	.6
	Wendover	31	3.7	<.1	.6
Wash:	Seattle	20	1.7	<.1	.2
	Spokane	20	1.4	.1	.2
Wyo:	Rock Springs	30	3.0	<.1	.6
	Worland	29	1.3	<.1	.4

[a] Individual values less thn the minimum detectable concentration (MDC) are set equal to the MDC for averaging. A monthly average less than the minimum reportable value of 0.1 pCi/m³ is reported as <0.1.

beta concentration within the network on a single filter during April was 7.7 pCi/m³ at Carlsbad, N. Mex.

From gamma spectrometry results, neptunium-239, uranium-237, cerium-141, barium-140, iodine-131, ruthenium-103, and zirconium-95 in varying combinations were identified on filters collected in Arizona, Arkansas, California, Colorado, Idaho, Louisiana, Missouri, Montana, Nebraska, Nevada, New Mexico, Oregon, Texas, Utah, and Wyoming. Table 2 lists the highest concentrations of these radionuclides, which are attributed to a nuclear detonation by the People's Republic of China on March 18, 1972.

Copies of this summary and listings of the daily gross beta and gamma spectrometry results are distributed to EPA regional offices and appropriate State agencies. Additional copies of the daily results may be obtained from the WERL upon written request.

Table 2. Maximum radionuclide concentrations, ASN April 1972

Location		Radionuclide	Concentration (pCi/m³)
N. Mex:	Carlsbad	Neptunium-239	14.0
Nev:	Indinn Springs	Uranium-237	1.1
	Elko	Cerium-141	.9
		Barium-140	.5
Ariz:	Kingman	Iodine-131	.3
Idaho:	Boise	Ruthenium-103	.3
	Twin Falls	Ruthenium-103	.3
Utah:	Parowan	Ruthenium-103	.3
Nev:	Fallon	Zirconium-95	3.2

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SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are such data as those obtained from human bone sampling, Alaskan surveillance, and environmental monitoring around nuclear facilities.

Offsite Surveillance Around the Nevada Test Site, July–December 1968[1]

Western Environmental Research Laboratory, EPA,[2] and Nevada Operations Office, AEC

Under a Memorandum of Understanding with the U.S. Atomic Energy Commission (AEC) the Southwestern Radiological Health Laboratory (SWRHL) conducted its continuing program of radiological surveillance, including monitoring and environmental sampling, in the public areas surrounding the Nevada Test Site (NTS) from July through December 1968. During this period, radioactivity was released from two nuclear rocket reactor tests at the Nuclear Rocket Development Station on NTS: Experimental Plan V (EP V) of the Phoebus 2A reactor test series conducted on July 18, and Experimental Plan III (EP III) of the Pewee I reactor test series on December 4. In addition, a Plowshare cratering experiment, Project Schooner, conducted at NTS on December 3, released radioactivity to the atmosphere that was detected in offsite populated locations.

Operational procedures

Comprehensive ground monitoring capabilities were maintained throughout this period. Mobile ground monitoring teams were positioned in the offsite areas prior to each event. Each monitor was equipped with an Eberline E-500B survey meter, a Baird-Atomic Model NE-148A Scintillator, and a Victoreen Radector, Model No. AGB-50B-Sr. Eberline RM-11 gamma-rate recorders at fixed locations documented cloud passage. An Air Force U-3A aircraft was used to track radioactive effluents and two SWRHL Turbo-Beech aircraft were used for sampling in the radioactive cloud to assess total cloud volume and to provide long-range tracking.

The Air Surveillance Network (ASN) operated about 110 stations in most of the States west of the Mississippi River. Additional samplers were located at strategic points to complement surveillance coverage for events from which releases of radioactivity were anticipated, i.e., Schooner, Phoebus 2A and Pewee I. The air samplers used were positive displacement vacuum pumps with an average flowrate of 10-cubic feet per minute. The filter media used were a 4-inch diameter glass fiber filter and an MSA charcoal cartridge.

In addition, 177 samples were collected from about 30 locations in the established milk sampling network. Samples were taken from both commercial dairies and private producers. Vegetation samples, including samples of milk-cow feed, were collected after known releases of radioactivity to help delineate the fallout pattern. Four hundred and five samples of both potable and nonpotable water were collected from 98 locations; nine stations in the Las

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[1] This article is a summary of report No. SWRHL-83r, "Off-site Surveillance Activities of the Southwestern Radiological Health Laboratory from July through December 1968."

[2] Formerly the Southwestern Radiological Health Laboratory, of the U.S. Department of Health, Education, and Welfare, Public Health Service, Bureau of Radiological Health.

Vegas Valley were added to the network primarily for tritium investigation.

Approximately 120 residents in the offsite areas wore film badges, and five film badges were placed at each of 133 dosimetry stations. One hundred and one of these stations were also equipped with three EG&G model TL-12 thermoluminescent dosimeters (TLD's). The film badge used contained DuPont type 545 film and has a 30 mR lower limit of detection.

A SWRHL medical officer was available to investigate reports of injuries alleged to be the result of the test series and to maintain liaison with local physicians. No injuries were reported. Veterinarian services were also provided by the SWRHL to conduct wildlife and domestic livestock investigations. Other community relations services included information centers which were established in towns around the NTS during the Benham Event (conducted December 19, 1968) to notify residents of possible ground motion hazards, to evacuate specified buildings and to process any complaints following the event.

Analytical procedures

All samples were analyzed at the SWRHL in Las Vegas. Air sample particulate filters were counted for beta radioactivity in a Beckman Widebeta low background, proportional counter system. Selected particulate filters, all charcoal cartridges, and water and milk samples were analyzed for gamma-emitting isotopes using a 4- by 4-inch NaI(T1) crystal coupled to a TMC gamma-pulse height analyzer. The lower limit of detection for gamma emitters in milk samples was 20 pCi/liter at the time of count. Gamma spectra were evaluated using a matrix technique which allowed for the determination of eight nuclides simultaneously.

Results

During this period, radioactivity was released from two nuclear rocket reactor tests at the Nuclear Rocket Development Station on NTS: EP V of Phoebus 2A reactor test series conducted on July 18, and EP III of the Pewee I reactor test series on December 4, 1968. In addition, a Plowshare cratering experiment, Project Schooner, conducted at NTS on December 8th, released radioactivity to the atmosphere and was detected in offsite populated locations.

Phoebus 2A EP V

Radioactive material released by this test was detected as far as Wendover, Utah. Night drainage winds carried small amounts of gaseous material to the south over Lathrop Wells, Nev.

The only gamma exposure rate instrument readings above background were obtained at Queen City Summit, an unpopulated Nevada location. The maximum reading was 0.1 mR/h. As shown in the following tables (*1–2*), radioiodines were found in milk and air samples (figures 1 and 2). No fresh fission products were found through dosimetry or in water sampling media.

Table 1. Maximum concentrations of iodine-131 in milk at four locations following Phoebus 2A EP V

Location azimuth—distance[a]	Date (1968)	Iodine-131 (pCi/liter)
Duckwater, Nev. (Halstead Ranch) 13°, 147 miles	7/20	90
Currant, Nev. (Blue Eagle Ranch) 18°, 122 miles	7/20	60
Cherry Creek, Nev. (Paris Ranch) 17°, 238 miles	7/24	30
Nyala, Nev. (Sharp Ranch) 16°, 102 miles	7/20	30

[a] From Test Cell C.

PeWee 1 EP III

Radioactive material released by this test was detected offsite by air samplers only. As indicated in figure 3, reactor effluent ranged widely, through in negligible amounts. Emissions from reactor pulse cooldown operations and possible portions of the main reactor cloud transported south by the evening drainage winds were detected in California, south and southwest of Test Cell C. The values shown in table 3 are from the combined activities collected by the glass fiber filters and charcoal cartridges.

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Table 2. **Five highest iodine-131 results and associated gross beta and radionuclide results from air sample media extrapolated to end of collection period (combined particulate and charcoal filters), Phoebus 2A EP V, July 1968**

Location azimuth—distance[a]	Time on off	Date on off	Average concentrations during collection period and integrated concentrations									
			Gross beta		Iodine-131		Tellurium-132		Iodine-133		Iodine-135	
			$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$	$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$	$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$	$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$	$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$
Queen City, Summit, Nev.,[b] 16°, 66 miles	2014 1050	7/18 7/19	420	22	40	2.1	65	3.4	310	17	85	4.4
Hiko, Nev.,[b] 14 miles N, 40 miles W, 25°, 100 miles	1905 1305	7/18 7/19	410	27	28	1.9	75	4.9	180	12	47	3.1
Hiko, Nev.,[b] 14 miles N, 30 miles W, 30°, 96 miles	1825 1136	7/18 7/19	500	31	24	1.5	81	5.0	140	8.6	48	3.0
Coyote Summit, Nev.,[b] 6.8 miles W on Highway 25, 28°, 64 miles	1940 1015	7/18 7/19	480	25	22	1.2	74	3.9	140	7.2	75	4.0
Currant, Nev., Blue Eagle Ranch, 10°, 123 miles	2000 1110	7/18 7/19	290	15	17	.89	46	2.4	100	5.2	47	2.5

[a] Azimuth and distance from Test Cell C.
[b] Temporary sampler.

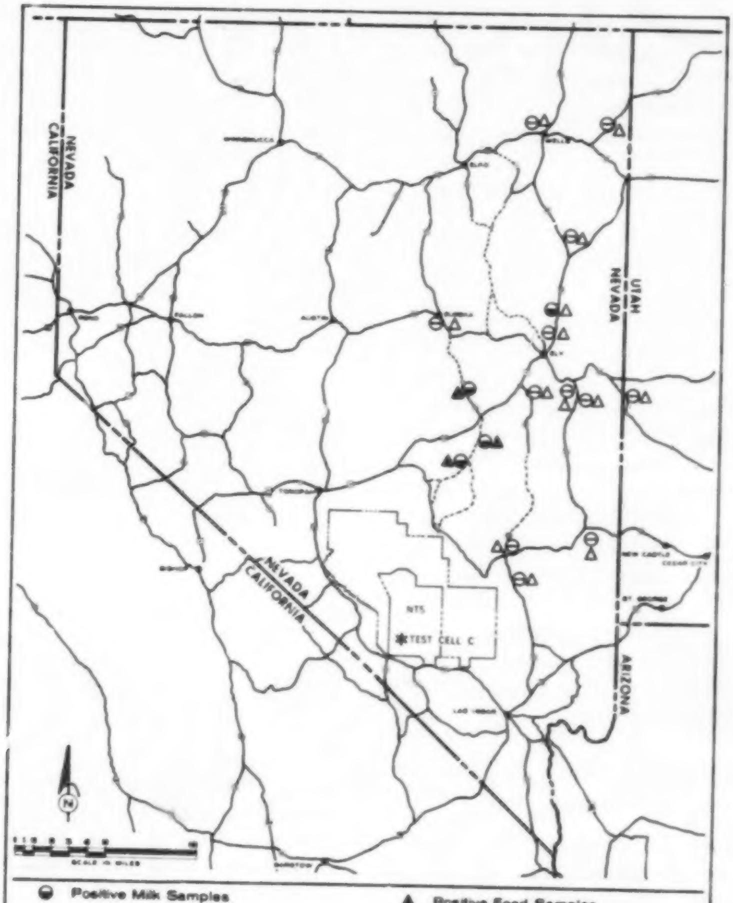

NEVADA
CALIFORNIA
UTAH
NEVADA
NEVADA
CALIFORNIA
ARIZONA
NTS
TEST CELL C
N
SCALE IN MILES
⊖ Positive Milk Samples
⊖ Background Milk Samples
▲ Positive Feed Samples
△ Background Feed Samples

Figure 1. Milk and cow feed results—Phoebus 2A, EP V

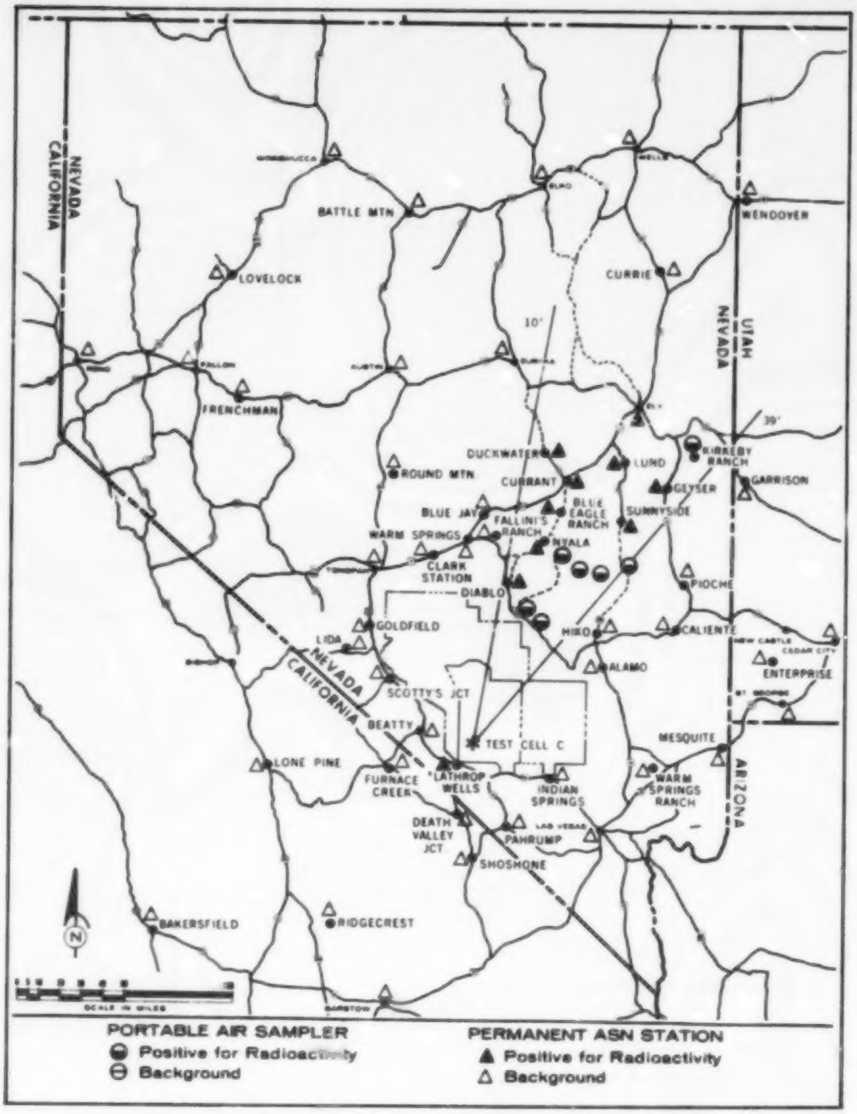

NEVADA
CALIFORNIA
UTAH
NEVADA
ARIZONA
BATTLE MTN
LOVELOCK
WENDOVER
CURRIE
FRENCHMAN
ROUND MTN
DUCKWATER
CURRANT
LUND
KIRKEBY RANCH
GARRISON
GEYSER
SUNNYSIDE
BLUE EAGLE RANCH
BLUE JAY
FALLINI'S RANCH
NYALA
WARM SPRINGS
CLARK STATION
DIABLO
PIOCHE
GOLDFIELD
LIDA
HIKO
CALIENTE
ALAMO
ENTERPRISE
SCOTTY'S JCT
BEATTY
MESQUITE
TEST CELL C
LONE PINE
FURNACE CREEK
LATHROP WELLS
INDIAN SPRINGS
WARM SPRINGS RANCH
DEATH VALLEY JCT
PAHRUMP
SHOSHONE
BAKERSFIELD
RIDGECREST
10°
39°
N
SCALE IN MILES
PORTABLE AIR SAMPLER
⊖ Positive for Radioactivity
⊖ Background
PERMANENT ASN STATION
▲ Positive for Radioactivity
△ Background

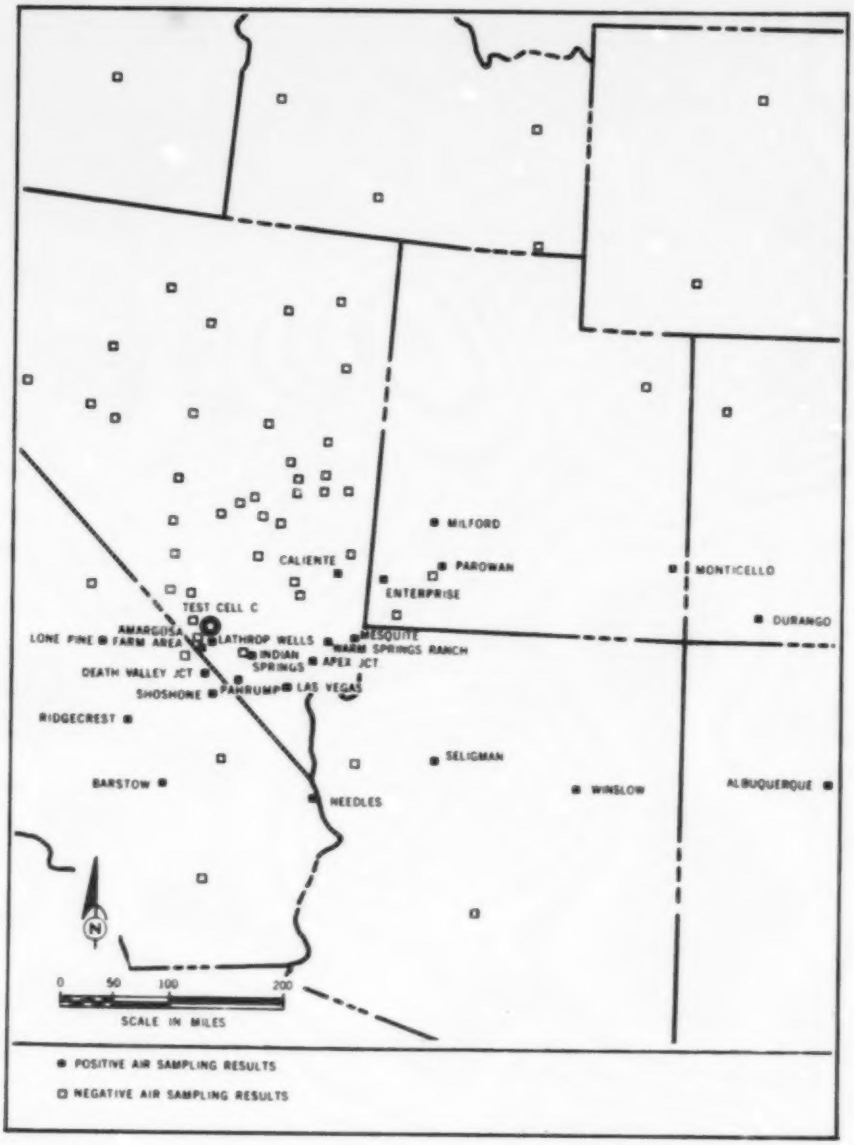
Figure 2. Air sampling results—Phoebus 2A, EP V

Schooner

Radionuclides released from this cratering experiment were chiefly tungsten-181 and tungsten-187. Deposition was detected throughout most of the Western United States (figures 4-7).

The peak gamma exposure rate observed by monitors with portable survey meters was 350 mR/h gross gamma at an unpopulated location near the Lincoln-Nye County line, just south of Nevada Highway 25. Peak exposure rate at a populated location was 8.5 mR/h gross gamma at the Diablo Highway Maintenance Station, 47 miles from surface zero (table 4).

72



MILFORD
PAROWAN
CALIENTE
ENTERPRISE
MONTICELLO
DURANGO
TEST CELL C
AMARGOSA
LONE PINE
FARM AREA
LATHROP WELLS
MESQUITE
WARM SPRINGS RANCH
INDIAN SPRINGS
APEX JCT
DEATH VALLEY JCT
SHOSHONE
PAHRUMP
LAS VEGAS
RIDGECREST
SELIGMAN
BARSTOW
WINSLOW
ALBUQUERQUE
NEEDLES
N
0
50
100
200
SCALE IN MILES
■ POSITIVE AIR SAMPLING RESULTS
□ NEGATIVE AIR SAMPLING RESULTS

Figure 3. Air sampling locations—Pewee 1, EP III

73

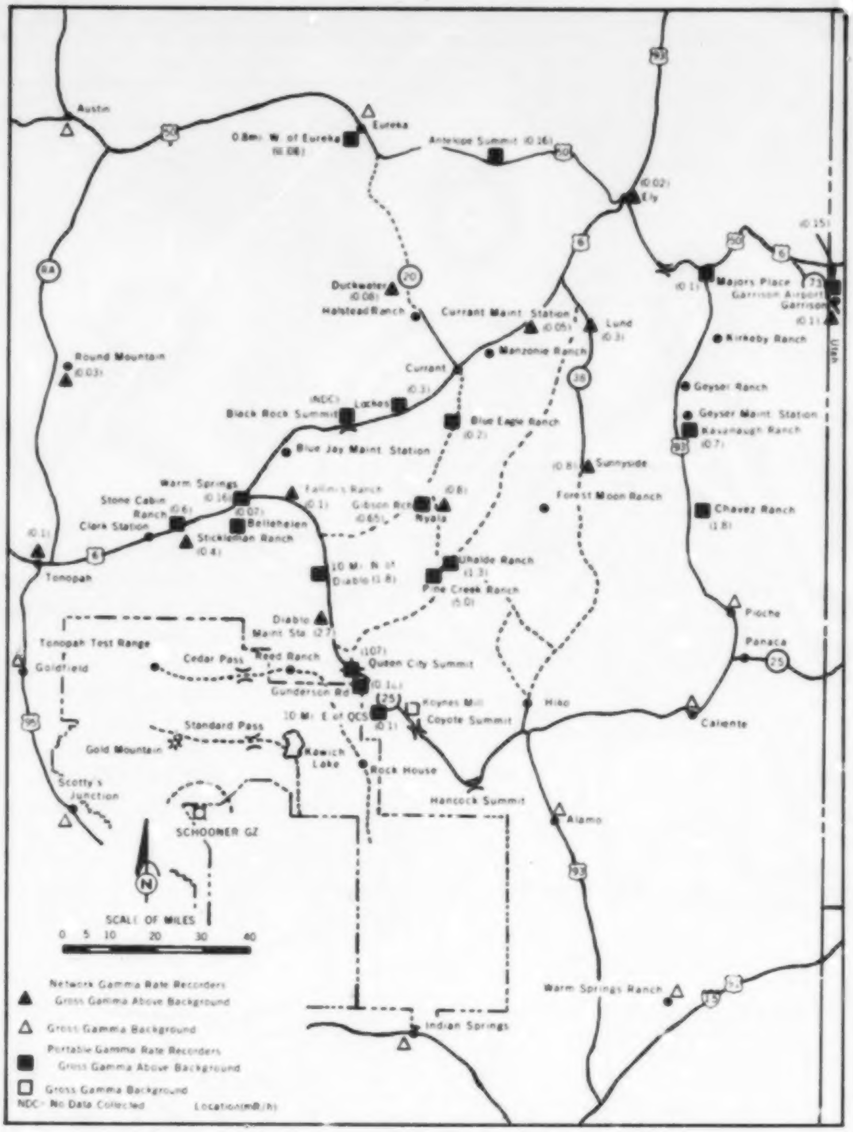

Austin
50
0.8mi W. of Eureka
(0.08)
Eureka
Antelope Summit (0.16)
50
93
(0.02)
Ely
6
8A
20
Duckwater
(0.08)
Halstead Ranch
Currant Maint. Station
(0.05)
Lund
(0.3)
Manzonie Ranch
Currant
(0.3)
Round Mountain
(0.03)
(NDC)
Black Rock Summit
Lockes
Blue Eagle Ranch
(0.2)
38
Blue Jay Maint. Station
(0.15)
50
6
Majors Place
(0.1)
Garrison Airport
Garrison
(0.1)
73
Utah
Kirkeby Ranch
Geyser Ranch
Geyser Maint. Station
Kavanaugh Ranch
(0.7)
93
(0.8)
Sunnyside
Forest Moon Ranch
Chavez Ranch
(1.8)
Warm Springs
(0.16)
(0.07)
Fallini's Ranch
(0.1)
Gibson Rch
(0.65)
(0.8)
Nyala
Stone Cabin
Ranch
(0.6)
Clark Station
Bellehelen
Stickleman Ranch
(0.4)
(0.1)
6
Tonopah
10 Mi. N. of
Diablo (1.8)
Uhalde Ranch
(1.3)
Pine Creek Ranch
(5.0)
Pioche
Panaca
25
Diablo
Maint. Sta. (2.7)
Tonopah Test Range
Goldfield
Cedar Pass
Reed Ranch
(107)
Queen City Summit
Gunderson Rd
(0.1)
25
Koynes Mill
Coyote Summit
10 Mi. E. of QCS
(0.1)
Hiko
Caliente
95
Standard Pass
Gold Mountain
Kawich
Lake
Rock House
Hancock Summit
Scotty's
Junction
SCHOONER GZ
Alamo
93
N
SCALE OF MILES
0 5 10 20 30 40
Network Gamma Rate Recorders
Gross Gamma Above Background
Gross Gamma Background
Portable Gamma Rate Recorders
Gross Gamma Above Background
Gross Gamma Background
NDC - No Data Collected
Location(mR/h)
Warm Springs Ranch
93
15
Indian Springs

Figure 4. Maximum observed exposure rates by recorders—Schooner

74

Table 3. Five highest iodine-131 results and associated gross beta radioactivity and radionuclide results from air sample media extrapolated to end of collection period (combined particulate and charcoal filters), Pewee 1 EP III, December 1968

Location azimuth—distance[a]	Time on off	Date on off	Average concentrations during collection period and integrated concentrations							
			Gross beta		Iodine-131		Tellurium-132		Iodine-133	
			$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$	$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$	$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$	$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$
Lathrop Wells,[b] Nev., Henderson Ranch, 286°, 25 miles	1445 1134	12/4 12/5	87	6.5	4.2	0.31	15	1.1	26	1.9
Las Vegas, Nev., 128°, 82 miles	0800 0800	12/5 12/6	63	5.5	3.4	.29	10	.86	7.0	.60
Lathrop Wells,[b] Nev., Copeland Ranch, 208°, 26 miles	1420 1225	12/4 12/5	82	5.8	3.4	.27	11	.88	18	1.5
Lathrop Wells, Nev., 208°, 15 miles	1645 0640	12/3 12/5	77	10	1.8	.2	5.3	.73	5.6	.77
Indian Springs, Nev., 117°, 38 miles	0900 0900	12/5 12/6	19	1.6	1.8	.16	8.9	.77	ND	ND

[a] Azimuth and distance from Test Cell C.
[b] Temporary sampler.
ND, nondetectable.

Table 4. Five highest integrated gamma exposures at populated locations based on portable survey instrument readings, Schooner, December 8, 1968

Location Azimuth—distance from surface zero	Time of first reading above background	Peak reading (mR/h)	Integrated exposure (mR)
Diablo, Nev. 33°, 47 miles	1100	8.5	188
Chavis Ranch, Nev. 57°, 127 miles	([a])	3.1	70
Uhalde Ranch, Nev. 45°, 75 miles	([a])	[b]2.0	62
Nyala, Nev. 84°, 76 miles	1312	.5	26
Stone Cabin Ranch, Nev. 356°, 61 miles	([a])	[b]1.2	34

[a] Monitor arrived after cloud arrival.
[b] Monitor may not have observed peak reading; however, the reading is comparable to peak readings in adjacent area.

For several months after the event, small concentrations of radioactivity were found on air sampling media to the northeast of the NTS as far as Eureka. Small amounts of tungsten nuclides were found as far south as Lake Charles, La., on February 13 and 14, and Indio, Calif., on February 16 and 17, 1968.

Inasmuch as the masking effect of the tungsten-187 somewhat inhibited quantitating radioiodines, relatively low concentrations of radioiodine were not detected on filter media. Best estimates indicated that 1,000 pCi/m³ of tungsten-187 would mask about 10 pCi/m³ of iodine-131. This 100:1 masking ratio seemed

Table 5. Five highest tungsten-187 results and associated gross beta radioactivity and radionuclide results from air sample media extrapolated to end of collection period, Schooner, December 1968

Location azimuth—distance[a]	Time on off	Date on off	Average concentration during collection period and integrated concentrations									
			Gross beta		Tungsten-187		Iodine-131		Iodine-133		Iodine-135	
			$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$	$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$	$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$	$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$	$\frac{pCi}{m^3}$	$\frac{\mu Ci\text{-}s}{m^3}$
Nevada:												
Clark Station, 356°, 55 miles	0955 2145	12/8 12/8	200,000	8,500	280,000	12,000	28	1.2	680	29	120	5.1
Warm Springs, 11°, 60 miles	0700 2130	12/8 12/8	31,000	1,600	44,000	2,300	8.2	.4	ND		220	11
Tonopah, 324°, 61 miles	1430 1145	12/8 12/9	28,000	2,100	26,000	2,000	ND		ND		ND	
Nyala, 36°, 77 miles	0800 2125	12/8 12/8	15,000	720	27,000	1,200	ND		ND		ND	
Kavanaugh Ranch, 52°, 133 miles	1150 2130	12/8 12/8	37,000	1,300	36,000	1,200	ND		36	1.2	34	1.2

[a] Azimuth and distance from surface zero.
ND, nondetectable.

75

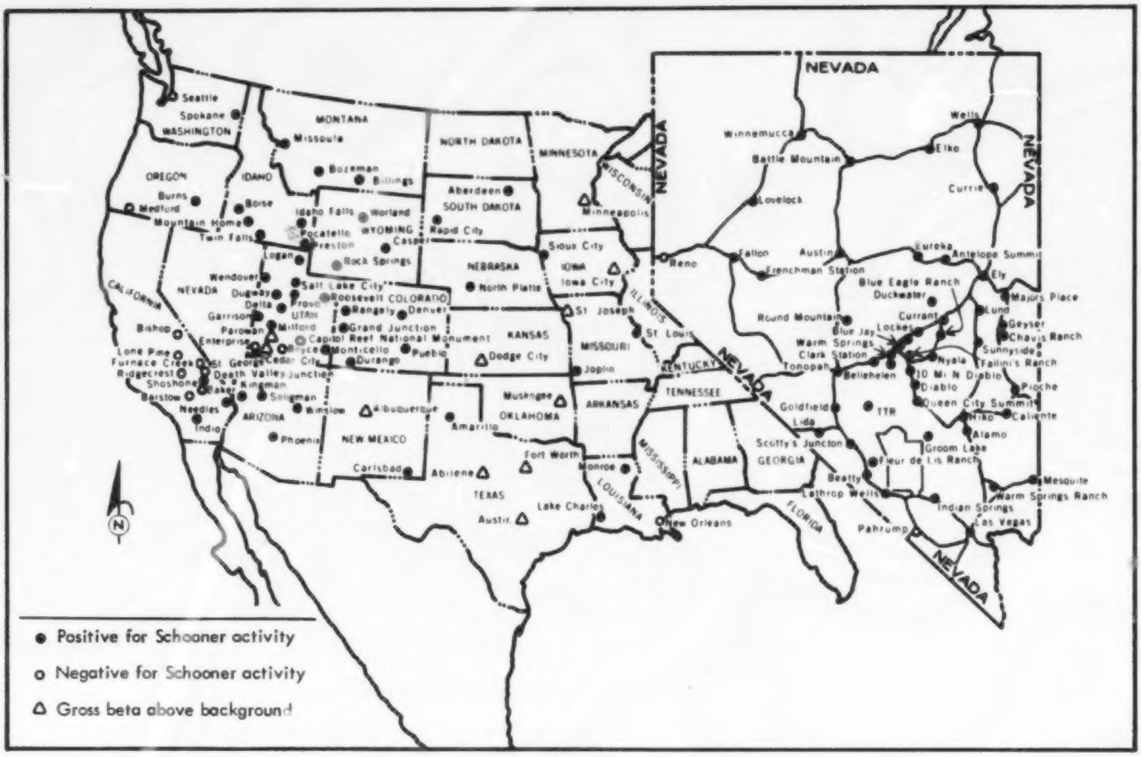

NEVADA
Seattle
Spokane
WASHINGTON
MONTANA
Missoula
Bozeman
Billings
NORTH DAKOTA
MINNESOTA
WISCONSIN
OREGON
IDAHO
Burns
Medford
Boise
Mountain Home
Twin Falls
Idaho Falls
Pocatello
Preston
Worland
WYOMING
Casper
Rock Springs
Aberdeen
SOUTH DAKOTA
Rapid City
Minneapolis
Logan
Wendover
NEVADA
Dugway
Delta
Salt Lake City
Provo
UTAH
Roosevelt
COLORADO
Rangely
Denver
NEBRASKA
North Platte
Sioux City
IOWA
Iowa City
ILLINOIS
CALIFORNIA
Garrison
Milford
Parowan
Grand Junction
Capitol Reef National Monument
Bishop
Enterprise
Bryce
Monticello
Pueblo
KANSAS
Dodge City
St Joseph
St Louis
MISSOURI
Lone Pine
Furnace Creek
Ridgecrest
Shoshone
Baker
Barstow
Needles
Indio
St George
Cedar City
Death Valley Junction
Kingman
Durango
Joplin
KENTUCKY
TENNESSEE
Seligman
Winslow
ARIZONA
Phoenix
Albuquerque
NEW MEXICO
Amarillo
Muskogee
OKLAHOMA
ARKANSAS
MISSISSIPPI
ALABAMA
GEORGIA
Carlsbad
Abilene
Fort Worth
TEXAS
Austin
Monroe
LOUISIANA
Lake Charles
New Orleans
FLORIDA
N
Winnemucca
Battle Mountain
Wells
Elko
Currie
Lovelock
Reno
Fallon
Austin
Frenchman Station
Eureka
Antelope Summit
Ely
Blue Eagle Ranch
Duckwater
Majors Place
Round Mountain
Currant
Lockes
Lund
Geyser
Chavis Ranch
Blue Jay
Warm Springs
Clark Station
Sunnyside
Failini's Ranch
Tonopah
Nyala
Bellehelen
10 Mi N Diablo
Diablo
Pioche
Goldfield
Lida
TTR
Queen City Summit
Hiko
Caliente
Alamo
Scotty's Junction
Groom Lake
Fleur de Lis Ranch
Beatty
Lathrop Wells
Mesquite
Warm Springs Ranch
Indian Springs
Las Vegas
Pahrump
● Positive for Schooner activity
o Negative for Schooner activity
△ Gross beta above background

Figure 5. Air sampling locations—Schooner

to hold for most filters. The five highest tungsten-187 results found in air samples are shown in table 5.

The highest tungsten-187 concentration in milk was 9,100 pCi/liter found in the December 9 sample from the Chavis Ranch north of Pioche, Nev. (table 6), and the iodine-131 concentration was 100 pCi/liter found in a December 11 sample collected near Abraham, Utah.

Table 7 presents the five highest tungsten-187 concentrations in water used for human consumption.

Table 6. Five highest concentrations of tungsten-187 in milk, Schooner, December 1968

Location azimuth—distance from surface zero	Date milked	Date collected (1968)	Time and date counted	Iodine-131 (pCi/liter)	Tungsten-187 (pCi/liter)
Nevada:					
Chavis Ranch 57°, 127 miles	12/09 p.m.	12/09	0015 12/10	<50	9,100
Chavis Ranch 57°, 127 miles	12/10 p.m.	12/10	2348 12/10	<50	7,300
Currant Mazonie Ranch 32°, 116 miles	12/09 a.m.	12/09	2345 12/09	<50	5,300
Casey's Ranch 39°, 82 miles	12/10 a.m.	12/10	2320 12/10	<50	4,400
Chavis Ranch 57°, 127 miles	12/11 a.m.	12/11	1900 12/11	<50	4,100

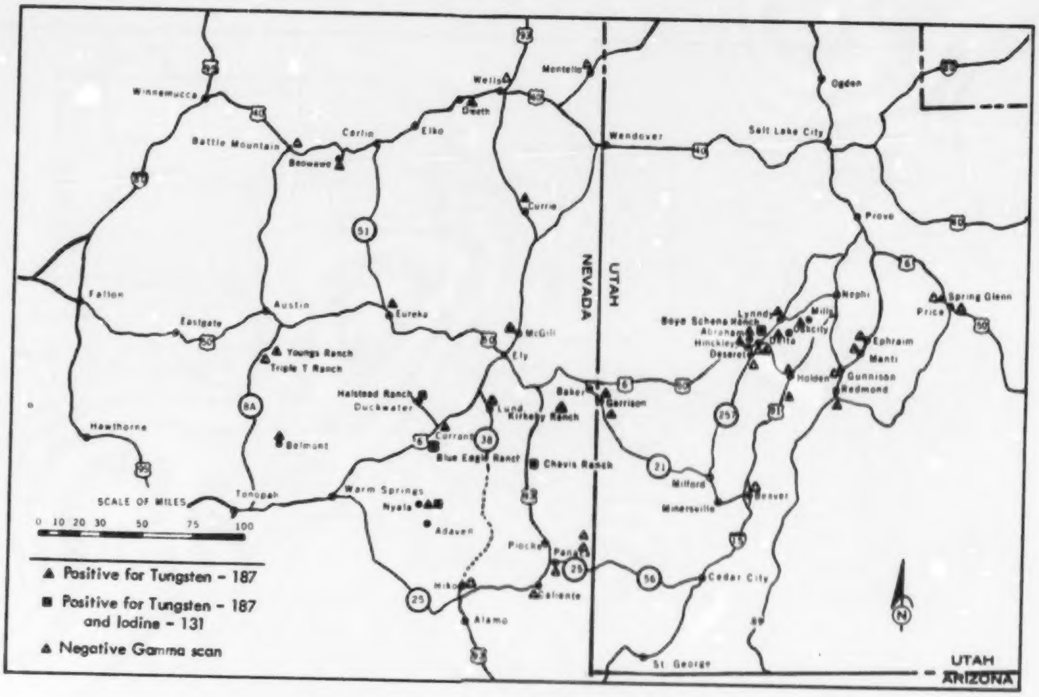

Winnemucca
Battle Mountain
Beowawe
Carlin
Elko
Deeth
Wells
Montello
Wendover
Salt Lake City
Ogden
Provo
Currie
Fallon
Eastgate
Austin
Eureka
McGill
Ely
Youngs Ranch
Triple T Ranch
Halstead Ranch
Duckwater
Belmont
Lund
Currant
Blue Eagle Ranch
Chevis Ranch
Baker
Garrison
Kirkeby Ranch
Hawthorne
Tonopah
Warm Springs
Nyala
Adaven
Pioche
Panaca
Caliente
Hiko
Alamo
Boyd Schena Ranch
Abraham
Hinckley
Deseret
Delta
Lynndy
Mills
Oakcity
Holden
Nephi
Ephraim
Manti
Gunnison
Redmond
Spring Glenn
Price
Milford
Minersville
Beaver
Cedar City
St. George
NEVADA
UTAH
ARIZONA
SCALE OF MILES
0 10 20 30 50 75 100
▲ Positive for Tungsten - 187
■ Positive for Tungsten - 187 and Iodine - 131
△ Negative Gamma scan
N

Figure 6. Milk sampling locations—Schooner

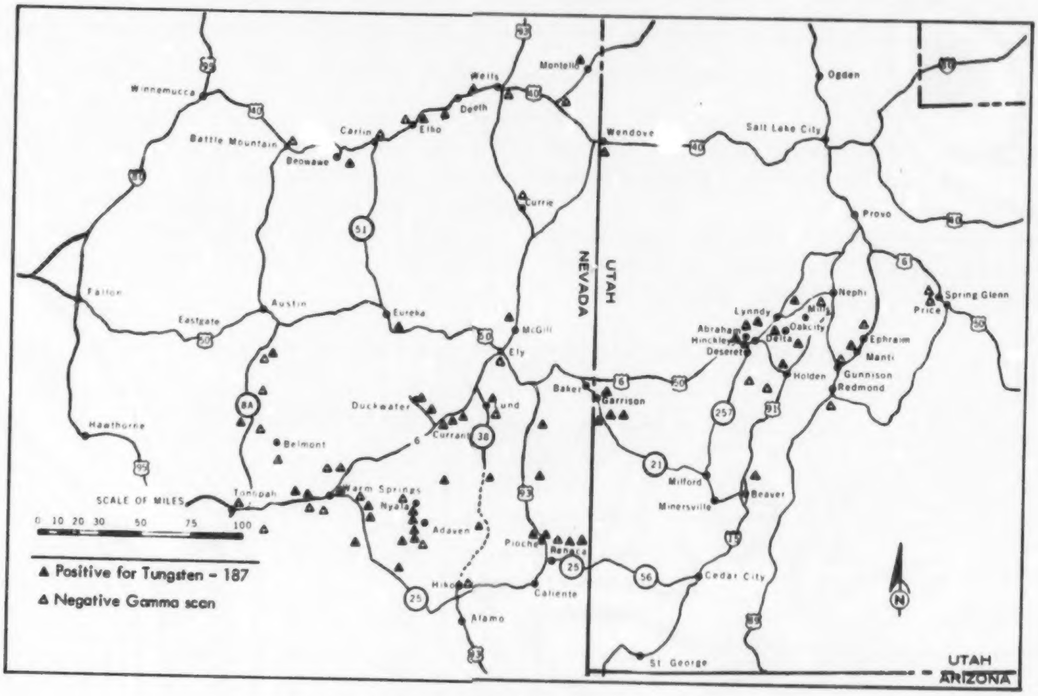

Winnemucca
Battle Mountain
Beowawe
Carlin
Elko
Deeth
Wells
Montello
Wendover
Salt Lake City
Ogden
Provo
Currie
Fallon
Eastgate
Austin
Eureka
McGill
Ely
Duckwater
Lund
Currant
Belmont
Hawthorne
Tonopah
Warm Springs
Nyala
Adaven
Pioche
Panaca
Caliente
Hiko
Alamo
Baker
Garrison
Abraham
Hinckley
Deseret
Delta
Lynndy
Mills
Oakcity
Holden
Nephi
Ephraim
Manti
Gunnison
Redmond
Spring Glenn
Price
Milford
Minersville
Beaver
Cedar City
St. George
NEVADA
UTAH
ARIZONA
SCALE OF MILES
0 10 20 30 50 75 100
▲ Positive for Tungsten - 187
△ Negative Gamma scan
N

Figure 7. Water sampling locations—Schooner

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Table 7. Five highest concentrations of tungsten-187 in water used for human consumption, Schooner, December 1968

Location azimuth and distance from ground zero	Date collected (1968)	Source	Tungsten-187 (pCi/liter)
Nevada:			
Simpson's Ranch, 42°, 75 miles	12/11	Spring	21,000
Uhalde's Ranch, 45°, 75 miles	12/10	Spring	10,000
Stone Cabin Ranch, 356°, 61 miles	12/11	Spring	8,300
Morrison Ranch, 11°, 167 miles	12/10	Well	2,400
Donahue Ranch, 63°, 145 miles	12/12	Stream	2,100

The maximum exposure shown by TLD or film badge was 4.76 R found at an unpopulated location 2 miles east of Queen City Summit. This exposure included cloud passage plus 5 days. One resident at a ranch about 75 miles from surface zero received 165 mR exposure while herding sheep along the line of maximum deposition.

Physiological parameters from ICRP II (*1*) were used to calculate a dose conversion factor for the ingestion of tungsten-187 based on beta radiation only. The dose to the G.I. tract is less than 40 mrad per μCi of tungsten-187 ingested.

Assuming that a person drank 1 liter of milk per day at the concentrations observed at Chavis Ranch, he would have consumed a total of 24,670 pCi of tungsten-187. If the entire ingested amount passes through the G.I. tract, this would correspond to an absorbed dose of about 1 mrad. Similarly, a dose of about 2 mrad can be estimated for a person drinking 1.6 liters of water per day having a concentration of 21,000 pCi of tungsten-187 as was observed at Simpson's Ranch.

Based on assumptions in FRC Report No. 5 (*2*), a peak concentration of 100 pCi/liter of iodine-131 in milk, observed at the Boyd Schena Ranch, would correspond to a dose of about 16 mrad to a hypothetical infant's thyroid. Since the FRC assumptions are based on fresh feeding conditions, this hypothetical infant dose estimate is conservative.

Conclusions

Using the critical receptor model, the maximum hypothetical thyroid dose calculated from iodine-131 in milk would be 16 mrad to a 2-gram infant thyroid as a result of Project Schooner. The sheepherder who received an exposure of 165 mR was in a location which is normally unpopulated.

Results obtained through environmental surveillance during this period indicated that no individual in the offsite area received an exposure from nuclear testing which exceeded the safety criteria established by the AEC.

Strontium-90 in Human Bone, July–September 1971[1]

Office of Radiation Programs
Environmental Protection Agency

To obtain data on the concentration of strontium-90 in man by age and geographical region, the Public Health Service began collecting human bone specimens in late 1961. Analyses of selected samples of people in older-age groups have shown their bone strontium-90 content to be low and age independent (*1*). Consequently, the target population includes children and young adults up to 25 years of age.

Although a few samples come from living persons as a result of surgical procedures, the majority are obtained post mortem. In the latter case, the specimens are limited to accident victims or persons who died of an acute disease process that was not likely to impair bone metabolism. For analytical purposes, a sample of at least 100 grams of wet bone is desired. Generally, this amount is readily available from older children, but it presents some difficulties in the case of infants and children under 5 years of age. Most specimens received to date have been vertebrae and ribs.

Laboratory procedures

The bones are analyzed at the Northeastern Radiological Health Laboratory, Winchester, Mass. Sample collection and preparation are explained elsewhere (*2*). Strontium-90 is measured by tributyl phosphate extraction of its yttrium daughter, which is precipitated as an oxalate. The strontium-90 content is then calculated (*3*) from the yttrium-90 activity. For the purpose of maintaining analytical reproducibility, "blind" duplicate analyses are performed on 10 to 20 percent of the samples.

The analytical results for strontium-90 in individual bones from persons dying during the third quarter (July–September) of 1971 are presented in table 1 in order of increasing age within each geographical region. These regions are indicated in figure 1. Reported values are

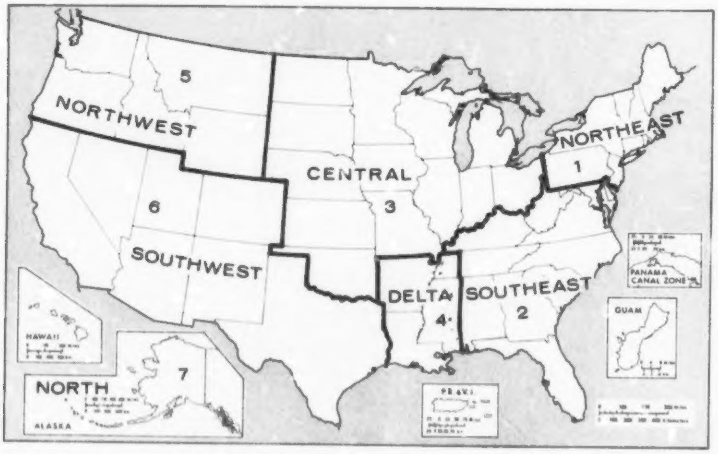

Figure 1. Geographical regions for human bone sampling

---

[1] Period during which death or surgical procedure occurred.

Table 1. Strontium-90 in human bone, July-September 1971

Bone region and State	Bone type[a]	Age[b] (years)	Sex	Strontium-90 concentration[c] (pCi/kg bone)	Calcium concentration (g/kg bone)	⁹⁰Sr/Ca (pCi/g)
Northeast:						
New York	V, R, I	0	M	31.9 ± 6.6	35.8	0.89
	V, R, I	0	F	25.0 ± 5.9	28.7	.87
Massachusetts	V	3	F	91.1 ±11.7	36.7	2.48
New York	V	3	M	79.3 ± 9.5	29.2	2.72
	V	11	F	50.6 ± 6.5	33.4	1.51
New Jersey	V	13	M	140.2 ±12.0	56.2	2.50
	V	15	F	90.1 ±10.3	50.0	1.80
New York	V	16	F	58.7 ± 9.9	32.6	1.80
Pennsylvania	V	17	F	124.6 ±13.9	57.0	2.19
Vermont	V	19	M	105.0 ± 9.0	53.2	1.97
New York	V	19	M	66.8 ± 8.4	41.9	1.59
Pennsylvania	V	20	M	52.9 ± 8.3	53.2	.99
New York	V	20	F	50.0 ± 7.4	32.6	1.53
	V	21	M	128.4 ±14.8	47.8	2.69
	V	21	M	85.1 ±10.5	41.0	2.08
Pennsylvania	V, R, S	23	F	83.7 ± 9.6	60.8	1.38
	V	24	M	163.8 ±12.0	51.6	3.18
Southeast:						
South Carolina	V	3	F	253.1 ±21.4	36.5	6.93
Maryland	V	5	M	65.6 ± 9.8	25.9	2.53
	V	6	F	61.8 ±10.8	33.6	1.84
South Carolina	V	8	M	85.0 ± 8.6	32.0	2.66
Tennessee	V, R	8	F	33.6 ± 5.8	28.5	1.18
North Carolina	V	11	M	121.5 ±14.6	38.1	3.19
South Carolina	V	14	M	133.2 ± 9.2	45.6	2.92
District of Columbia	V	14	F	105.9 ±13.5	55.8	1.90
South Carolina	V	14	F	110.5 ±10.6	47.6	2.32
Kentucky	V	16	F	136.5 ±14.6	57.7	2.36
North Carolina	V	17	M	94.1 ±10.7	42.5	2.21
South Carolina	V	17	M	115.5 ± 8.7	48.9	2.36
Maryland	V	19	M	99.9 ± 8.5	49.3	2.03
	V	19	M	69.7 ± 8.7	49.4	1.41
South Carolina	V	19	M	197.2 ±13.5	57.8	3.41
Maryland	V	20	M	125.1 ±10.5	48.0	2.61
	V	20	M	120.4 ±10.0	55.8	2.16
	V	20	F	91.8 ± 9.0	47.4	1.94
South Carolina	V	20	M	134.3 ±13.7	60.4	2.22
	V	20	M	48.5 ± 5.2	33.3	1.46
Kentucky	V	20	M	110.6 ±13.6	57.5	1.92
Maryland	V	21	M	98.2 ±11.1	45.3	2.17
South Carolina	V	21	M	46.4 ± 5.3	35.0	1.32
Maryland	V	22	M	74.5 ± 9.1	50.0	1.49
	V	22	M	136.9 ±12.5	58.6	2.34
	V	22	M	78.8 ± 7.2	43.6	1.81
	V	23	M	83.0 ± 9.5	64.5	1.29
	V	24	M	91.3 ±10.2	56.1	1.63
	V	24	M	65.0 ± 6.7	46.1	1.41
South Carolina	V	24	M	171.8 ±14.3	57.1	3.01
	V	24	M	111.3 ± 9.9	62.0	1.80
Maryland	V	25	M	54.9 ± 8.7	43.4	1.27
	V	25	M	74.8 ± 9.1	52.7	1.42
	V	25	F	114.2 ±10.7	56.1	2.04
	V	25	M	50.6 ± 7.2	52.6	.96
	V	25	M	86.2 ±12.0	58.0	1.48
	V	25	F	91.3 ± 9.9	65.6	1.39
Central:						
Wisconsin	V	4	M	58.1 ± 8.4	31.0	1.88
	V	5	M	40.2 ± 5.4	24.3	1.66
	V	5	F	120.7 ±11.0	41.2	2.93
Ohio	V	5	M	73.4 ±11.0	38.9	1.89
Wisconsin	V	7	F	43.3 ± 6.8	33.1	1.31
	V	7	F	51.9 ± 7.5	31.7	1.64
Ohio	V	9	M	65.6 ±11.0	36.8	1.78
Minnesota	V	10	M	60.7 ± 8.5	35.2	1.72
Ohio	V	11	M	48.2 ± 7.0	35.1	1.37
Indiana	V	11	M	76.0 ± 9.1	40.5	1.88
Ohio	V	12	M	95.9 ±10.5	42.9	2.24
Wisconsin	V	12	M	99.3 ± 8.8	39.2	2.54
Ohio	V	14	M	93.8 ± 8.6	53.0	1.77
	V	14	M	148.2 ±13.4	63.5	2.33
	V	15	M	90.9 ± 9.3	44.2	2.06
	V	15	M	125.7 ±11.6	51.8	2.42
	V	16	M	128.4 ±12.6	47.4	2.71
Michigan	V	16	F	123.3 ±11.8	78.8	1.56
Ohio	V	16	M	91.1 ±10.3	56.1	1.62
	V	16	M	120.2 ±11.5	38.9	3.09
	V	17	M	92.6 ± 9.1	44.1	2.10
Minnesota	V	17	M	57.6 ± 6.0	42.5	1.35
	V	17	M	60.6 ± 8.7	44.1	1.37
Ohio	V	18	M	145.9 ±10.3	53.1	2.75
	V	18	F	155.6 ±15.1	70.3	2.21
	V	18	M	94.8 ± 8.8	53.8	1.76
	V	18	F	100.2 ±12.9	50.9	1.97
	V	18	M	82.3 ±10.0	49.0	1.68
	V	18	F	100.5 ±10.1	46.1	2.18

See footnotes at end of table.

Table 1. Strontium-90 in human bone, July-September 1971—continued

Bone region and State	Bone type[a]	Age[b] (years)	Sex	Strontium-90 concentration[c] (pCi/kg bone)	Calcium concentration (g/kg bone)	^{90}Sr/Ca (pCi/g)
Minnesota	V	18	F	79.0 ± 7.7	47.9	1.65
Ohio	V	19	M	76.0 ± 9.4	68.4	1.11
	V	19	M	84.4 ± 8.1	57.5	1.47
	V	20	M	81.3 ± 8.9	49.0	1.66
	V	20	M	69.5 ± 9.0	54.0	1.29
	V	21	M	92.0 ± 8.0	42.2	2.18
	V	21	M	101.1 ± 9.9	59.1	1.71
	V	22	F	102.1 ±11.1	53.0	1.93
	V	22	M	73.4 ± 9.0	54.8	1.34
	V	22	M	80.6 ±11.0	51.8	1.56
	V	22	M	133.8 ±16.0	77.0	1.74
	V	22	F	69.6 ± 9.2	58.8	1.18
	V	22	M	69.5 ±11.2	56.1	1.24
	V	22	M	79.5 ± 7.9	53.8	1.48
	V	22	M	103.1 ±13.8	63.8	1.62
	V	23	F	94.2 ±13.5	54.4	1.73
	V	24	M	84.1 ±10.5	62.3	1.35
	V	24	F	53.4 ± 9.4	53.9	.99
	V	24	M	94.7 ±11.2	70.1	1.35
	V	24	M	106.2 ±11.0	59.0	1.80
	V	24	M	88.9 ± 9.2	74.2	1.20
	V	25	M	53.1 ± 7.4	44.3	1.20
Northwest:						
Oregon	V	13	M	39.7 ± 6.6	39.0	1.02
Washington	V	14	M	45.8 ± 5.7	27.8	1.65
Oregon	V	15	M	69.4 ± 9.1	56.3	1.23
	V	16	M	49.2 ± 6.5	38.6	1.27
	V	21	M	56.2 ±10.6	53.5	1.05
	V	24	M	54.5 ± 6.8	41.3	1.32
North:						
Alaska	V	18	F	646.3 ±55.1	134.7	4.80

[a] Type of bone: V, vertebrae; R, rib; I, ilium; S, sternum.
[b] Age given as of last birthday prior to death.
[c] Two-sigma counting error.

given in picocuries of strontium-90 per kilogram of bone (as rough indication of dose) and per gram of calcium (for comparison with other data and for purposes of model development). Two-sigma counting errors are reported for the bone concentration.

Following the pattern of earlier reports, subsequent articles will continue to provide interpretation of the data at appropriate stages in the program (*2–6*).

Recent coverage in *Radiation Data and Reports:*

Period	Issue
July–September 1970	June 1971
October–December 1970	September 1971
January–March 1971	March 1972
April–June 1971	May 1972

REFERENCES

(*1*) RIVERA, J. Strontium-90 in human vertebrae, 1962–1963. Radiol Health Data 5:511–513 (October 1964).

(*2*) WEISS, E. S., W. H. LAND, K. H. FALTER, and R. M. HALLISEY, Strontium-90 content of human bones, 1961–1963. Radiol Health Data 5:231–239 (May 1964).

(*3*) PUBLIC HEALTH SERVICE, NORTHEASTERN RADIOLOGICAL HEALTH LABORATORY. Analysis of environmental samples, chemical and radiochemical procedures, NERHL 64-1. Northeastern Radiological Health Laboratory, Winchester, Mass. (April 1964).

(*4*) GAFFNEY, G. W., R. M. HALLISEY, M. S. MILLER, and A. S. GOLDIN. Strontium-90 in human bone, 1962–1963. Radiol Health Data 5:620–628 (December 1964).

(*5*) HALLISEY, R. M., and M. A. WALL. Strontium-90 in human bone, 1964–1965. Radiol Health Data Rep 8:415–419 (August 1967).

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Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission (AEC) receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the "AEC Manual."[1]

A summary of the environmental radioactivity data follows for the Brookhaven National Laboratory.

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[1] Title 10, Code to Federal Regulations, Part 20, "Standards for Protection Against Radiation" contains essentially the standards published in Chapter 0524 of the AEC Manual.

---

1. Brookhaven National Laboratory[2]
January–June 1969

Associated Universities, Inc.
Upton, N.Y.

The Brookhaven National Laboratory (BNL) operations may affect the environmental levels of radiation in three ways: (1) by radioactivity in the cooling air from the research reactors (2) by radiation from an ecology forest gamma-ray source, and (3) by low-level radioactive liquid wastes released to a stream that forms one of the headwaters of the Peconic River (figure 1). The radiation levels resulting from reactor air effluent and the ecology forest source are monitored continuously by four stations located at the site boundary. The liquid waste effluent from the laboratory sewage processing plant is monitored continuously at the point where the stream leaves the site.

Area monitoring

The average weekly radiation levels at the Brookhaven National Laboratory site perimeter (figure 2), due to laboratory operations, are given in table 1. Radiation levels at the northeast perimeter are somewhat greater than at other monitoring stations due to a cesium-137 source located in the nearby forest. The radiation levels at this location were 15 percent of the established Atomic Energy Commission (AEC) radiation protection standard of 500 mrem/a for individuals in the general population. The levels at the other three perimeter stations are

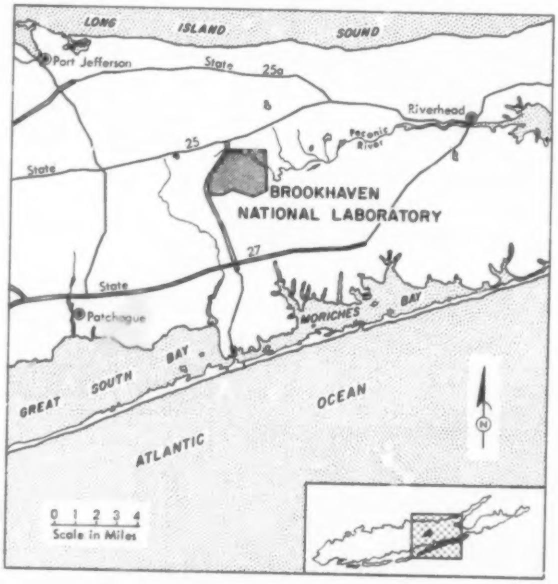

Figure 1. Brookhaven National Laboratory and surrounding area

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[2] Summarized from "Effects of Brookhaven National Laboratory on Environmental Levels of Radioactivity during the First Half of 1969," Associated Universities Inc., Upton, N.Y. 11973.

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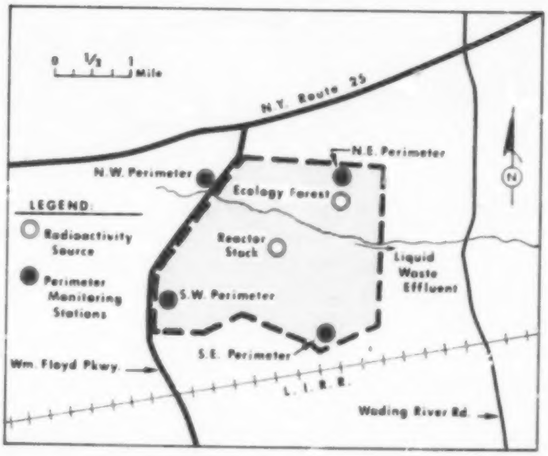

Figure 2. Brookhaven National Laboratory monitoring station locations

Table 1. External gamma radioactivity at BNL site perimeter due to laboratory[a] operations, January-June 1969

1969	Average exposure rates (mR/week)			
	Northwest perimeter	Southwest perimeter	Southeast perimeter	Northeast perimeter
January	0.05	0.01	0.04	1.23
February	.04	.00	.14	1.30
March	.00	.00	.20	1.37
April	.00	.00	.00	1.47
May	.00	.00	.01	1.65
June	.43	.00	.09	2.04
January-June	.08	.00	.08	1.51
Highest weekly reading (January-June)	1.38	0.04	0.76	2.44
Average undisturbed background (January-June)	1.62	1.62	1.67	1.52

[a] Due principally to argon-41 in reactor cooling air and at the northeast perimeter, to the ecology forest cesium-137 source.

attributed to the Brookhaven Graphite Research Reactor being operated on a partially reduced schedule. Values of radiation background levels undisturbed by laboratory operations also have been included in table 1 for purposes of comparison.

Water monitoring

The liquid waste effluent from the laboratory sewage processing plant is monitored continuously at the point where the stream leaves the BNL site. The average concentration and total amount of gross beta radioactivity in the liquid waste effluent, at the site boundary, are shown in table 2 for January–June 1969.

Analysis of composite samples of the effluent has shown that, on the average, less than 20 percent of the radioactivity consists of strontium-90 and that no appreciable amounts of radioactive iodine or bone-seeking radionuclides, such as radium, are present. Under these conditions, the applicable AEC radiation protection standard for discharge of liquid waste to uncontrolled areas would be 1 nCi/liter. The observed concentration at BNL was 2 percent of the standard.

Most gross beta measurement instruments are not sensitive to low energy beta emitters, such as tritium, for which special analytical methods must be employed. The concentration and amounts of tritium found during this reporting period in the laboratory's liquid waste effluent are also shown in table 2. The applicable AEC standard is 3 μCi/liter, averaged over a period of 1 year. The observed concentration of tritium at BNL was 0.1 percent of this standard.

Table 2. Gross beta radioactivity in liquid waste effluent at BNL site boundary, January-June 1969

1969	Volume of flow (gallons/day)	Average beta radioactivity concentration (pCi/liter)	Total beta radioactivity concentration discharged (mCi)	Tritium concentration (nCi/liter)	Tritium radioactivity (Ci)
January	620,000	11	0.7	2	0.1
February	470,000	12	.6	2	.1
March	458,000	21	1.3	5	.8
April	682,000	14	1.0	2	.1
May	732,000	23	1.8	10	.7
June	403,000	15	.8	4	.3
January-June	[a]551,000	16	6.2	[a]3	1.7

[a] Not a straight arithmetic monthly average because it takes into account variations in volume of flow or the different number of days in each month.

Reported Nuclear Detonations, July 1972

(Includes seismic signals presumably from foreign nuclear detonations)

The U.S. Atomic Energy Commission conducted an underground nuclear test at its Nevada Test Site on July 20, 1972. The test was in the yield range of less than 20 kilotons of TNT equivalent.

Information in this section is based on data received during the month, and is subject to change as additional information may become available. Persons requiring information for purposes of compiling announced nuclear detonation statistics are advised to contact the Division of Public Information, U.S. Atomic Energy Commission, Washington, D.C. 20545.

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RADIATION DATA AND REPORTS

Volume 13, Number 9, September 1972

Radiation Data and Reports, a monthly publication of the Environmental Protection Agency, presents data and reports provided by Federal, State, and foreign governmental agencies, and other cooperating organizations. Pertinent original data and interpretive manuscripts are invited from investigators.

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. This responsibility was delegated to the Bureau of Radiological Health, Public Health Service. Pursuant to the Reorganization Plan No. 3 of 1970, effective December 2, 1970, this responsibility was transferred to the Radiation Office of the Environmental Protection Agency which was established by this reorganization.

The Federal agencies listed below appoint their representatives to a Board of Editorial Advisors. Members of the Board advise on general publications policy; secure appropriate data and manuscripts from their agencies; and review those contents which relate to the special functions of their agencies.

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U.S. ENVIRONMENTAL PROTECTION AGENCY
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Reports

Environmental Monitoring and Disposal of Radioactive Wastes From U.S. Naval Nuclear-Powered Ships and Their Support Facilities, 1971

M. E. Miles, G. L. Sjoblom, and R. D. Burke [1]

This report assesses the effect on the environment of disposal of radioactive wastes originating from U.S. Naval nuclear propulsion plants and their support facilities. The total radioactivity discharged into all ports and harbors from the more than 100 reactor plants and supporting tenders, bases, and shipyards was less than 0.002 curie in 1971. This small amount of radioactivity has had no significant or discernable effect on the quality of the human environment. Results of environmental surveys of harbor water and bottom sediment for gross radioactivity and for cobalt-60 show that (1) no increase in radioactivity has been detected in harbor water, (2) discharges of liquid wastes from U.S. Naval nuclear-powered ships have not caused a measurable increase in the general background radioactivity of the environment, and (3) low-level cobalt-60 radioactivity is still detectable in localized areas of harbor bottom sediment around a few piers at operating bases and shipyards where maintenance and overhaul of Navy nuclear-powered ships have been conducted over a period of several years; these levels have decreased in recent years.

This report confirms that procedures used by the Navy to control discharges of radioactivity from U.S. Naval nuclear-powered ships and their support facilities are effective in protecting the environment and the health and safety of the general public.

The radioactivity in wastes discussed in this report originates in the pressurized water reactors of U.S. Naval nuclear-powered ships. As of the end of 1971, there were 96 nuclear-powered submarines and four nuclear-powered surface ships in operation. Support facilities involved in construction, maintenance, overhaul, and refueling of these nuclear propulsion plants include nine shipyards, 10 tenders, and two submarine bases. This report first describes disposal of radioactive liquid wastes, then solid wastes. The final section discusses monitoring of the environment to determine the effects of radioactive discharges.

Radioactive liquid waste disposal

In the shipboard reactors, pressurized water circulating through the reactor core picks up the heat of nuclear reaction. Reactor cooling water circulates through a closed piping system to heat exchangers which transfer the heat to water in a secondary steam system isolated from the primary cooling water. The steam is then used as the source of power for the propulsion plant as well as for auxiliary machinery. Discharges of radioactivity from ships occur primarily when reactor coolant water expands as a result of being heated to operating temperature; this coolant passes through a purification system ion exchange resin bed prior to being transferred from the ship.

The principal source of radioactivity in liquid wastes is from trace amounts of corrosion and wear products from reactor plant metal surfaces in contact with reactor cooling water. Radionuclides with half-lives greater than one day in these corrosion and wear products include tungsten-187, chromium-51, hafnium-181, iron-59, iron-55, zirconium-95, tantalum-182, manganese-54, cobalt-58, and cobalt-60. The predominant and also longest-lived of these is cobalt-60, which has a 5.3 year half-life; cobalt-60 also has the most restrictive concentration limit in water listed by organizations which set radiological standards (*1–3*) for these corrosion and wear radionuclides. Therefore, radioactive waste disposal is conservatively controlled by assuming that all the long-lived radioactivity is cobalt-60.

---

[1] Nuclear Power Directorate, Naval Ship Systems Command, Department of the Navy.

Liquid wastes discharged by support facilities result from operations such as draining shipboard reactor systems, decontaminating radioactivity contaminated piping system, and laundering anti-contamination clothing worn by personnel. These facilities are equipped with processing systems to remove most of the radioactivity from liquid waste prior to discharge into harbors.

Procedures for control of radioactive liquid wastes in harbors

Discharge limits for radioactive liquid wastes from U.S. Naval nuclear-powered ships and their support facilities are consistent with applicable recommendations issued by the Federal Radiation Council (incorporated into the Environmental Protection Agency late in 1970), U.S. Atomic Energy Commission (AEC), National Council on Radiation Protection and Measurements, International Commission on Radiological Protection (ICRP), International Atomic Energy Agency, and National Academy of Sciences—National Research Council (*1–7*). In consonance with these recommendations, the policy of the U.S. Navy is to reduce to the minimum practicable the amounts of radioactivity discharged within 12 miles from shore including into harbors. Keeping discharges small minimized the radioactivity available to build up in the environment or to concentrate in marine life. To implement this policy of minimizing discharges, the Navy has issued standard instructions defining the radioactive waste disposal limits and procedures to be used by U.S. Naval nuclear-powered ships and their support facilities. These instructions were reviewed and concurred in by the U.S. Atomic Energy Commission and the U.S. Public Health Service.

Liquid waste discharges in harbors

The total amounts of long-lived radioactivity discharged into harbors and seas within 12 miles from shore during the past 5 years are summarized in table 1, which updates information in references *8–13*. Included are data on discharges from U.S. Naval nuclear-powered ships and from supporting shipyards, tenders, and submarine bases. Locations listed in table 1 include all operating bases and home ports in the United States and overseas as well as all other ports which have been visited by Naval nuclear-powered ships. The quantities of radioactivity listed in this table are conservatively reported as if the entire radioactivity consisted of cobalt-60, which is the predominant long-lived radionuclide and also has the most stringent discharge limits.

Although this table shows both gallons and curies discharged, the curie data are the most significant. In 1971 the gallons shown in table 1 for most of these organizations are no more than many single U.S. homes discharge in their sewage systems each year.

The table shows that nearly all the radioactive discharges occur where shipyards are overhauling nuclear-powered ships. In 1971, for example, under 1 percent of the less than 0.002 curie total was discharged into harbors other than those where nuclear-powered ships were overhauled.

Table 1 shows that the total long-lived radioactivity discharged annually for the last five years into harbors has been a small fraction of a curie per year and was less than 0.002 curie in 1971 from all U.S. Naval nuclear propulsion plants and support facilities. This amount of radioactivity has had no significant or discernable effect on the quality of the human environment.

Other radionuclides

Reactor coolant also contains short-lived radionuclides with half-lives of seconds to hours The highest concentrations in reactor coolant are from nitrogen-16 (7 second half-life), nitrogen-13 (10 minute half-life), fluorine-18 (1.8 hour half-life), argon-41 (1.8 hour half-life), and manganese-56 (2.6 hour half-life). For the longest-lived of these, about one day after discharge from an operating reactor, the concentration is reduced to one thousandth of the initial concentration, and in about 2 days, the concentration is reduced to one millionth. Most discharges from ships occur during heating up prior to extensive power operation of the reactor, when short-lived radionuclides

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Table 1. Radioactive liquid waste discharged to harbors, from U.S. Naval nuclear-powered ships and their support facilities for 1967 through 1971 [a]

Facility	1967		1968		1969		1970		1971	
	Thousand gallons	Curies	Thousand gallons	Curies	Thousand gallons	Curies	Thousand gallons	Curies	Thousand gallons	Curies
Portsmouth, N.H.; Naval Shipyard	265	0.012	171	0.006	87	0.002	68	0.002	51	<0.001
Groton-New London, Conn; Electric Boat Division, tender at S[illegible] Pier, and submarine base	606	.011	469	.006	615	.006	359	.004	258	<.001
Newport News, Va; Newport News Shipbuilding	1,533	.034	1,146	.025	870	.022	1,466	.013	262	<.001
Norfolk, Va; Naval Shipyard and tender	1,784	.034	184	.004	102	.005	98	.001	38	<.001
Charleston, S.C.; Naval Shipyard and tenders	320	.011	227	.004	131	.001	58	<.001	45	<.001
Pascagoula, Miss; Ingalls Nuclear Division	6	<.001	9	<.001	8	<.001	7	<.001	28	<.001
San Diego, Calif; tenders at Ballast Point	28	.001	<1	<.001	<1	<.001	<1	<.001	<1	<.001
Long Beach, Calif; Naval Shipyard and Base	<1	<.001	<1	<.001	2	<.001	<1	<.001	<1	<.001
Vallejo, Calif; Mare Island Naval Shipyard	140	.001	391	.027	80	.001	121	.002	219	<.001
Bremerton, Wash; Puget Sound Naval Shipyard	246	.002	182	.001	152	.001	136	<.001	98	<.001
Pearl Harbor, Hawaii; Naval Shipyard and submarine base	683	.008	886	.006	1,279	.008	258	.002	90	<.001
Apra Harbor, Guam	42	.002	26	.001	<1	<.001	<1	<.001	<1	<.001
All other harbors, United States and foreign	<1	<.001	<1	<.001	<1	<.001	<1	<.001	<1	<.001
Total	5,653	0.116	3,691	0.081	3,326	0.048	2,571	0.024	1,089	<0.002

[a] Radioactivity data has been standardized to cobalt-60 and excludes tritium. Volumes are prior to dilution. A total of 0.02 curie was discharged into the river at Quincy, Mass., from 1961 through March 1969 when all work on U.S. Naval nuclear-powered ships was discontinued at General Dynamics, Quincy Division. A total of 0.01 curies was discharged into the river near Camden, N.J., from 1960 through June 1967 when all work on U.S. Naval nuclear-powered ships was discontinued at New York Shipbuilding Corporation. Slight differences in volumes and radioactivity data from past reports results from using more significant figures in this table. Volumes less than 500 gallons are shown as <1 thousand. Quantities less than 0.0005 curie are shown as <0.001 curie.

are at low concentrations in coolant. Total short-lived radioactivity in such a discharge is less than 0.001 curie. Because of their small amounts and rapid decay, short-lived radionuclides are insignificant compared to long-lived radionuclides for waste disposal considerations.

Fission products produced in the reactor are retained within the fuel elements. The fission gases, krypton and xenon, are also retained within the fuel elements. However, trace quantities of naturally occurring uranium impurities in reactor structural materials release small amounts of fission products to reactor coolant. The concentrations of fission products and the volumes of reactor coolant discharged are so low, however, that the total radioactivity attributed to long-lived fission product radionuclides, strontium-90 and cesium-137, in discharges from U.S. Naval nuclear-powered ships and their support facilities has been less than 0.001 curie per year and for all harbors combined. Fallout of these same fission products often has been more than this in one rainfall in a single harbor.

Tritium

Small amounts of tritium are formed in reactor coolant systems as a result of neutron interaction with the approximately 0.015 percent of naturally occurring deuterium present in water, and other nuclear reactions. Although tritium has a 12-year half-life, the radiation produced is of such low energy that the radioactivity concentration guide issued by the ICRP, the AEC and by other standard-setting organizations is 100 times higher for tritium than for cobalt-60. This tritium is in the oxide form and chemically indistinguishable from water; therefore it does not concentrate significantly in marine life or collect on sediment as do other radionuclides.

Tritium is naturally present in the environment because it is generated by cosmic radiation in the upper atmosphere. Reference *14* reports that the production rate from this source is about six million curies per year, which through rainfall causes a tritium inventory in the oceans of about one hundred million curies. Because of this naturally occurring tritium, much larger discharges of tritium than are conceivable from Naval nuclear reactors would be required to make a measurable change in the background tritium concentration.

The total amount of tritium discharged during each of the last 5 years from all U.S. Naval nuclear-powered ships and their supporting tenders, bases, and shipyards has been less than 200 curies. Most of these discharges have been in the ocean more than 12 miles from shore. This total tritium discharged from the entire nuclear Navy is less than typical electrical generating pressurized water nuclear power stations discharge each year (*15, 16*). Such discharges are too small to measurably increase the tritium concentration in the environment. Therefore, tritium has been excluded from the data in other sections of this report.

Liquid waste discharges at sea

Radioactive liquid wastes are also discharged at sea under strict controls. These ocean discharges are consistent with recommendations of the Council on Environmental Quality made in 1970 to the President (*17*). Procedures and limits for ocean discharges have been consistent with commendations made by the National Academy of Sciences—National Research Council (*5*) and by the International Atomic Energy Agency (*6*). Ship discharges have contained much less radioactivity than these reports considered would be acceptable. Total long-lived radioactivity for recent years, excluding tritium, discharged farther than 12 miles from shore by all U.S. Naval nuclear-powered ships and their supporting tenders is shown in table 2. Discharge of the radioactivity reported in table 2 has no significant effect on the radioactivity of the marine environment.

Table 2. Radioactive liquid waste discharged at sea by U.S. Naval nuclear-powered ships and supporting tenders

Year	Quantity (thousand gallons)	Radioactivity (Ci)
1967	1,520	1.3
1968	1,630	1.1
1969	1,570	1.7
1970	1,220	.8
1971	1,840	.8

Reactor coolant is purified through an ion exchange bed. This resin becomes expended and periodically requires replacement. Until 1970 expended resin was occasionally discharged at sea in accordance with procedures recommended in the National Academy of Sciences—National Research Council Publication 658, "Radioactive Waste Disposal from Nuclear Powered Ships" (*5*). Publication 658 developed procedures to assure no adverse impact on the environment if up to 300 nuclear-powered ships each discharged 400 curies of radioactivity every 2 months off the shores of the United States. Even though the actual discharges of radioactivity in resin by the entire Navy each year was less than one thousandth of the amounts envisioned by the National Academy of Sciences, continued effort by the Navy resulted in improvements which permitted discontinuing sea disposal of ion exchange resin in 1970. Depleted resin is currently packaged for land disposal as solid radioactive waste in AEC or State-licensed burial grounds.

Solid radioactive waste disposal

During maintenance and overhaul operations, solid low-level radioactive wastes consisting of contaminated rags, plastic bags, paper, filters, ion exchange resin and scrap materials are collected by nuclear-powered ships and their support facilities. High-level radioactive wastes are associated with expended reactor fuel, all of which is transferred to the AEC for processing ashore.

Solid radioactive materials from Naval nuclear-powered ships are not dumped at sea since the Navy procedures prohibit sea disposal of solid radioactive materials. Solid radioactive waste materials are packaged in strong, tight containers, shielded as necessary, and shipped to burial sites licensed by the AEC or a State under agreement with AEC. Shipyards and other shore facilities are not permitted to dispose of radioactive solid wastes by burial on their own sites. All packaging and shipping of radioactive materials is performed in strict compliance with U.S. Department of Transportation and AEC requirements.

Table 3 summarizes total radioactivity and volumes of radioactive solid waste disposal for the last 5 years. Table 3 does not include expended fuel which is processed by the AEC at special facilities ashore.

Table 3. Radioactive solid waste from U.S. Naval nuclear-powered ships and their support facilities for 1967 through 1971 [a]

Facility	1967		1968		1969		1970		1971	
	Thousand cubic feet	Curies	Thousand cubic feet	Curies	Thousand cubic feet	Curies	Thousand cubic feet	Curies	Thousand cubic feet	Curies
Portsmouth, N.H.; Naval Shipyard	30	198	31	151	8	8	14	16	12	9
Groton, New London, Conn; Electric Boat Division, tender at State Pier and submarine base	5	17	4	21	8	328	12	140	18	13
Newport News, Va; Newport News Shipbuilding	17	702	14	10	17	382	28	312	21	165
Norfolk, Va; Naval Shipyard and tender	11	86	2	11	6	8	9	146	10	33
Charleston, S.C; Naval Shipyard and tenders	15	62	14	110	15	9	8	6	6	4
Pascagoula, Miss; Ingalls Nuclear Division	0	0	0	0	1	<1	0	0	2	<1
San Diego, Calif; tenders at Ballast Point	1	<1	1	8	<1	2	<1	1	2	<1
Long Beach, Calif; Naval Shipyard and Base	<1	<1	<1	<1	<1	<1	<1	<1	1	<1
Vallejo, Calif; Mare Island Naval Shipyard	9	23	8	7	8	5	12	2	22	25
Bremerton, Wash; Puget Sound Naval Shipyard	14	193	14	48	11	42	18	1,327	21	59
Pearl Harbor, Hawaii; Naval Shipyard and submarine base	1	1	3	6	4	3	5	4	4	2
Total	103	1,272	92	372	78	788	106	1,954	119	311

[a] This table includes all radioactive waste from tenders and nuclear-powered ships. This radioactivity is primarily cobalt-60. The radioactive waste is shipped to burial facilities licensed by the AEC or State. Slight differences from past reports result from using different number of significant figures in this table. Volumes less than 500 cubic feet are reported as <1 thousand and activity less than 0.5 curie is reported as <1 curie.

Because of efforts to minimize solid waste and the utilization of compaction equipment, total volumes have remained nearly constant in spite of increasing work caused by increasing numbers of ships. The average annual volume for the entire Naval nuclear propulsion program could be contained in a cube measuring 15 yards on a side. The radioactivity does not require excessively long-time care in the licensed burial grounds since the principal radionuclides do not have half-lives longer than 5 years. In 100 years, such radioactivity will have decayed to one millionth the initial radioactivity. In less than 200 years, the total of all radioactivity, conservatively assumed to be cobalt-60 in table 3, will have decayed to less than one millionth of a curie and would not be detectable in the burial grounds using sensitive monitoring instruments.

Two U.S. Navy nuclear-powered submarines have been lost at sea in the Atlantic Ocean. The submarine THRESHER sank 10 April 1963, 100 miles from land in water 8,500 feet deep at latitude 41°45′N and longitude 65°00′W. The submarine SCORPION sank between 21 and 27 May 1968, 400 miles southwest of the Azores in more than 10,000 feet of water. The reactors used in all U.S. Naval submarines and surface ships are designed to minimize potential hazards to the environment even through the most severe casualty conditions such as actual sinking of the ship. First, the reactor core is so designed that it is physically impossible for it to explode like a bomb. Second, the reactor fuel elements are made of materials that are extremely corrosion resistant, even in sea water. The reactor core could remain submerged in sea water for decades without release of fission products while the radioactivity decays, since the protective cladding on the fuel elements corrodes only a few millionths of an inch per year. Thus, in the event of a serious accident where the reactor is completely submerged in sea water, the fuel elements will remain intact for an indefinite period of time and the radioactive material contained in these fuel elements should not be released. The maximum rate of release and dispersal of the radioactivity in the ocean, even if the protective cladding on the fuel were destroyed, would be so low as to be insignificant.

Radiation measurements, water samples, bottom sediment samples and debris collected from the area where THRESHER sank have been analyzed for radioactivity by various laboratories with highly sensitive equipment. Similarly, sea water and bottom sediment samples taken near SCORPION's hull have been analyzed for radioactivity. None of these samples showed radioactivity above naturally occurring background levels and none showed evidence of radioactivity released from either THRESHER or SCORPION.

Environmental monitoring

Environmental monitoring surveys for radioactivity are periodically performed in harbors where U.S. Naval nuclear-powered ships are built or overhauled and where these ships have home ports or operating bases. These surveys are performed to verify the adequacy of liquid waste disposal procedures and limits. To ensure thoroughness and objectivity these surveys are made as independently as practicable from waste disposal operations. Samples from each harbor monitored are also checked at least annually by an AEC laboratory to ensure analytical procedures are correct and standardized. These AEC laboratory results have been consistent with shipyard and operating base results. As a further independent check of environmental monitoring, a laboratory of the U.S. Public Health Service (now part of the Environmental Protection Agency) has conducted detailed surveys of selected harbors (*18-20*). This laboratory has monitored the harbors at Charleston, S. C; Pearl Harbor, Hawaii; San Diego, Calif; Vallejo, Calif; New London, Conn; Newport News, Va; and Norfolk, Va. Navy monitoring results have been consistent with these surveys.

The Navy monitoring program initially emphasized analyzing water because it is used by boats and swimmers and because fish live in this water. Preoperational surveys were conducted in the harbors before use for nuclear-powered ships to establish base levels of gross beta activity of harbor water and sediment in the vicinity of berths to be used by nuclear-powered ships and locations where support facilities might discharge processed water. Results of the water monitoring showed that superimposed on the naturally occurring radioactivity (*21*) of potassium-40 in harbor water were large variations of other radioactivity from fallout. Surface layers of rainwater before much dilution in harbor water sometimes have measured more than 100 times higher than this natural radioactivity. In addition, rates of introduction of naturally radioactive radium, uranium, thorium and their associated radionuclides varied. Results of early monitoring for naturally occurring radioactivity of sediment samples were up to 10 times the beta activity present in sea water and varied widely from sample to sample and from month to month in a single harbor.

The current Navy environmental monitoring program is based on the results of the initial monitoring. This program presently consists of analyzing samples of harbor water and sediment, supplemented by shoreline surveys, posted film badges and effluent monitoring.

Five water samples are taken in each harbor once each quarter year in areas where nuclear-powered ships berth and from upstream and downstream locations. These samples are analyzed for gross gamma radioactivity and for cobalt-60 content. Procedures for analysis will detect cobalt-60 if its concentration exceeds one three hundredth of the nonoccupational AEC limit (*1*). No cobalt-60 has been detected in any of the 2,960 water samples from all harbors monitored.

Commencing in 1963 at Navy request, a radiological laboratory, now part of the Environmental Protection Agency, made additional analyses of samples from some harbors to identify radionuclides present in sediment. These analyses showed that cobalt-60 was the predominant radionuclide added to sediment from Naval nuclear reactor operations. Therefore, Navy monitoring procedures were changed to collect 20 to 120 sediment samples in each harbor once each quarter year. Standard 6-inch-square samplers modified to collect only the top one-half to one inch of sediment are used. The top layer was selected because it should be more mobile and more accessible to marine life than deeper layers. The samples are analyzed for gross gamma radioactivity and for cobalt-60. Results of the 4,001 sediment samples from harbors monitored by the Navy in the United States and possessions for 1971 are summarized in table 4.

Evaluation of the data summarized in table 4 shows that low-level cobalt-60 radioactivity in harbor bottom sediment is detectable around

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Table 4. Summary of 1971 surveys for cobalt-60 in bottom sediment of U.S. harbors where U.S. Naval nuclear-powered ships have been regularly based, overhauled or built

Facility	Number of samples with cobalt-60			Total bottom area with cobalt-60 over 3 pCi/g[c] (km²)	Estimated total cobalt-60 in top layer of sediment[d] (Ci)
	<3 pCi/g[a]	3-30 pCi/g	>30-300 pCi/g[b]		
Portsmouth, N.H.; Naval Shipyard	176	0	0	0	ND
Groton, New London, Conn; Electric Boat Division, State Pier, and submarine base	461	40	2	0.1	0.02
Newport News, Va; Newport News Shipbuilding	152	0	0	0	ND
Norfolk, Va; Naval Shipyard and Base	344	0	0	0	ND
Charleston, S.C.; Naval Shipyard and Bases	384	0	0	0	ND
Pascagoula, Miss; Ingalls Nuclear Division	208	0	0	0	ND
San Diego, Calif; Navy Piers at Ballast Point	158	0	0	0	ND
Long Beach, Calif: Naval Shipyard and Base	153	0	0	0	ND
Vallejo, Calif; Mare Island Naval Shipyard	397	0	0	0	ND
Bremerton, Wash: Puget Sound Naval Shipyard	150	0	0	0	ND
Pearl Harbor, Hawaii; Naval Shipyard and submarine base	350	1	0	.001	ND
Apra Harbor, Guam	120	0	0	0	ND

[a] Minimum detectable radioactivity is approximately 1 pCi/g wet weight. Results in units of pCi/cm³ range from two to four times the value in pCi/g.

[b] One square kilometer is approximately equal to 0.4 square mile. Areas with cobalt-60 over 3 pCi/g were in immediate vicinity of piers used for berthing nuclear-powered ships.

[c] Maximum radioactivity in these samples was 87 pCi/g.

[d] Where total cobalt-60 in the surface sediment layer is less than 0.01 curie, ND is reported. Samples more than 1-foot-deep from several harbors show that total cobalt-60 present may be two to five times that measured in the surface layer.

a few piers at operating bases and shipyards where nuclear-powered ship maintenance and overhauls have been conducted over a period of several years. Cobalt-60 is not detectable above background levels in general harbor bottom areas away from these piers. Maximum total radioactivity observed in a U.S. harbor is less than one curie of cobalt-60. This radioactivity is small compared to background, since the quantity of naturally occurring radioactivity, such as potassium-40, radium, uranium and thorium, present in the sediment of a typical harbor amounts to hundreds of curies. Comparison to previous environmental monitoring data (*8-13*) shows that these environmental cobalt-60 levels have been steadily decreasing.

The first data column in table 4 includes all samples with less than 3 picocuries of cobalt-60 per gram of sediment. These low levels are difficult to measure because the levels of radioactivity in sediment from other sources are much higher. The value of 30 picocuries per gram was selected for the top of the second range of data, since it corresponds to the upper limit for exposure (*1, 3*) even if consumed continuously by members of the general public. Although sediment can not be consumed by humans, it might serve as a food source for marine life. Data on uptake of cobalt-60 from sediment by marine life obtained to date show that in the salt water harbor bottom environments, no significant buildup of cobalt-60 occurs in marine life. Such buildup is unlikely because the cobalt is in the form of insoluble metallic oxides. Therefore the third range of up to 300 picocuries per gram is selected as a range which would not cause members of the general public to receive radiation exposure approaching the values set in references *1-4*. Concentrations of cobalt-60 up to 300 picocuries per gram are so low that the AEC does not require those who might possess them to be licensed. If concentrations higher than 300 picocuries per gram were to persist over substantial areas of a harbor bottom, further monitoring would be performed to determine if any of this radioactivity were being taken up by marine life for eventual consumption in food. Because of the low concentrations noted in table 4, monitoring of radioactivity in marine life has not been necessary as part of the routine environmental monitoring programs in these harbors.

Estimates of the radiation exposure to members of the general public from radioactivity discharged into river and harbor waters and sediment have been made as discussed in references *21-22*, by analyzing the pathways whereby radioactivity might be transmitted from the marine environment to man. These analyses considered direct exposure to sediment such as along shorelines and by drinking harbor water, and indirect exposure by consumption of bottom feeding fish or shellfish. These analyses showed that personnel exposure from this radioactivity would be far too low to measure and could only be estimated. Based on radioactivity discharges of the amounts and concentrations reported in table 1 of this report, the maximum radiation exposure in a year to any member of the general public would be less than 0.01 millirem. This is less than one ten thousandth of the average annual exposure of 125 millirems (*7*) to members of the general public from natural radioactivity and less than the exposure from medical diagnostic x-rays. Thus the radioactivity discharged into harbors from the Naval nuclear propulsion program has not caused significant radiation exposure to the general public.

For comparison, references *23-24* contain evaluations by AEC laboratories of the effects on the environment from the accumulation near points of discharge of radionuclides from several nuclear reactors. These reports conclude for these other reactors that radioactivity levels much greater than shown in table 4 have caused no significant radiation exposure to the general public.

In all monitored harbors, shoreline areas uncovered at low tide are surveyed twice a year for radiation levels with sensitive radiation detectors to determine if any radioactivity from bottom sediment washed ashore. All results were the same as background radiation levels in these regions, approximately 0.01 millirem per hour. Thus there is no evidence in these ports that radioactivity from sediment is washing ashore.

Film badges are continuously posted at locations outside the boundaries of areas where radioactive work is performed. These films showed radiation exposure to the general public outside these facilities was not above that received from natural background radiation levels.

Naval nuclear reactors and their support facilities are designed to ensure that there are no significant discharges of radioactivity in airborne exhausts. Radiological controls are exercised in support facilities to preclude exposure of working personnel to airborne radioactivity exceeding limits such as specified in reference (*1*). Further, all air exhausted from these facilities is passed through high efficiency particulate air filters and monitored during discharge. There were no discharges of airborne radioactivity above concentrations normally present in the atmosphere.

In addition to the locations listed in table 4, environmental monitoring is performed by U.S. Navy submarine tenders which serve as operating bases for U.S. Naval nuclear-powered submarines in Rota, Spain, and Holy Loch, Scotland. Results of the surveys in the harbor at Rota, Spain, have not shown detectable cobalt-60 in harbor bottom sediment samples. In 1965 in Holy Loch, more cobalt-60 radioactivity than expected was detected in harbor bottom sediment and on shoreline mud flat areas uncovered at low tide. However, there had been no increase of harbor water radioactivity in Holy Loch above normal background levels. Joint United States and British assessments of survey results confirmed that radiation levels in the vicinity of the Holy Loch anchorage were far below those which were at all likely to cause an individual to receive radiation exposure approaching limits for members of the general public. Environmental monitoring during 1971 showed radioactivity levels in Holy Loch are steadily declining and are now less than half of the levels in 1965.

Monitoring of harbor water and sediment has also been performed in Sasebo Harbor, Japan. In 1968 a Japanese boat monitoring for radioactivity near a U.S. Naval nuclear-powered ship recorded transient abnormal radiation readings. The anomalous readings did not recur on prompt return to the same area. Separate United States and Japanese analyses of water and sediment samples showed no radioactivity attributable to nuclear propulsion plants. The nuclear-powered ships had not discharged any radioactivity. Joint Japanese and United States assessments of the data from the monitoring boat concluded that even if the anomalous readings had been caused by discharges from the nuclear-powered ship, no significant radiation exposure to the public would have resulted.

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Conclusions

1. The total radioactivity discharged into all ports and harbors from the U.S. Naval nuclear propulsion program was less than 0.002 curie in 1971.

2. No increase of radioactivity above normal background levels has been detected in harbor water where U.S. Naval nuclear-powered ships are based, overhauled, or constructed.

3. Discharges of liquid wastes from U.S. Naval nuclear-powered ships have not caused a measurable increase in the general background radioactivity of the environment.

4. Low-level cobalt-60 radioactivity in harbor bottom sediment is detectable around a few piers at operating bases and shipyards where nuclear-powered ship maintenance and overhauls have been conducted over a period of several years. Cobalt-60 is not detectable above background levels in general harbor bottom areas away from these piers. Maximum total radioactivity observed in a U.S. harbor of less than one curie of cobalt-60 is small compared to the naturally occurring radioactivity. Comparison to previous environmental monitoring data summarized in references *8* to *13* shows that these environmental cobalt-60 levels have been steadily decreasing.

5. Procedures used by the Navy to control discharges of radioactivity from U.S. Naval nuclear-powered ships and their support facilities have been effective in protecting the environment and the health and safety of the general public.

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Data

SECTION I. MILK AND FOOD

Milk Surveillance, May 1972

Although milk is only one of the sources of dietary intake of environmental radioactivity, it is the food item that is most useful as an indicator of the general population's intake of radionuclide contaminants resulting from environmental releases. Fresh milk is consumed by a large segment of the population and contains several of the biologically important radionuclides that may be released to the environment from nuclear activities. In addition, milk is produced and consumed on a regular basis, is convenient to handle and analyze, and samples representative of general population consumption can be readily obtained. Therefore, milk sampling networks have been found to be an effective mechanism for obtaining information on current radionuclide concentrations and long-term trends. From such information, public health agencies can determine the need for further investigation or corrective public health action.

The Pasteurized Milk Network (PMN) sponsored by the Office of Radiation Programs, Environmental Protection Agency, and the Office of Food Sanitation, Food and Drug Administration, Public Health Service, consists of 63 sampling stations: 61 located in the United States, one in Puerto Rico, and one in the Canal Zone. Many of the State health departments also conduct local milk surveillance programs which provide more comprehensive coverage within the individual State. Data from 15 of these State networks are reported routinely in *Radiation Data and Reports*. Additional networks for the routine surveillance of radioactivity in milk in the Western Hemisphere and their sponsoring organizations are:

Pan American Milk Sampling Program (Pan American Health Organization and U.S. Environmental Protection Agency)—5 sampling stations

Canadian Milk Network (Radiation Protection Division, Canadian Department of National Health and Welfare)—16 sampling stations

The sampling locations that make up the networks presently reporting in *Radiation Data and Reports* are shown in figure 1. Based on the similar purpose for these sampling activities, the present format integrates the complementary data that are routinely obtained by these several milk networks.

Radionuclide and element coverage

Considerable experience has established that relatively few of the many radionuclides that are formed as a result of nuclear fission become incorporated in milk (*1*). Most of the possible radiocontaminants are eliminated by the selective metabolism of the cow, which restricts gastrointestinal uptake and secretion into the milk. The five fission-product radionuclides which commonly occur in milk are strontium-89, strontium-90, iodine-131, cesium-137, and barium-140. A sixth radionuclide, potassium-40, occurs naturally in 0.0118 percent (*2*) abundance of the element potassium, resulting in a specific activity for potassium-40 of 830 pCi/g total potassium.

Two stable elements which are found in milk, calcium and potassium, have been used as a means for assessing the biological behavior of metabolically similar radionuclides (radio-

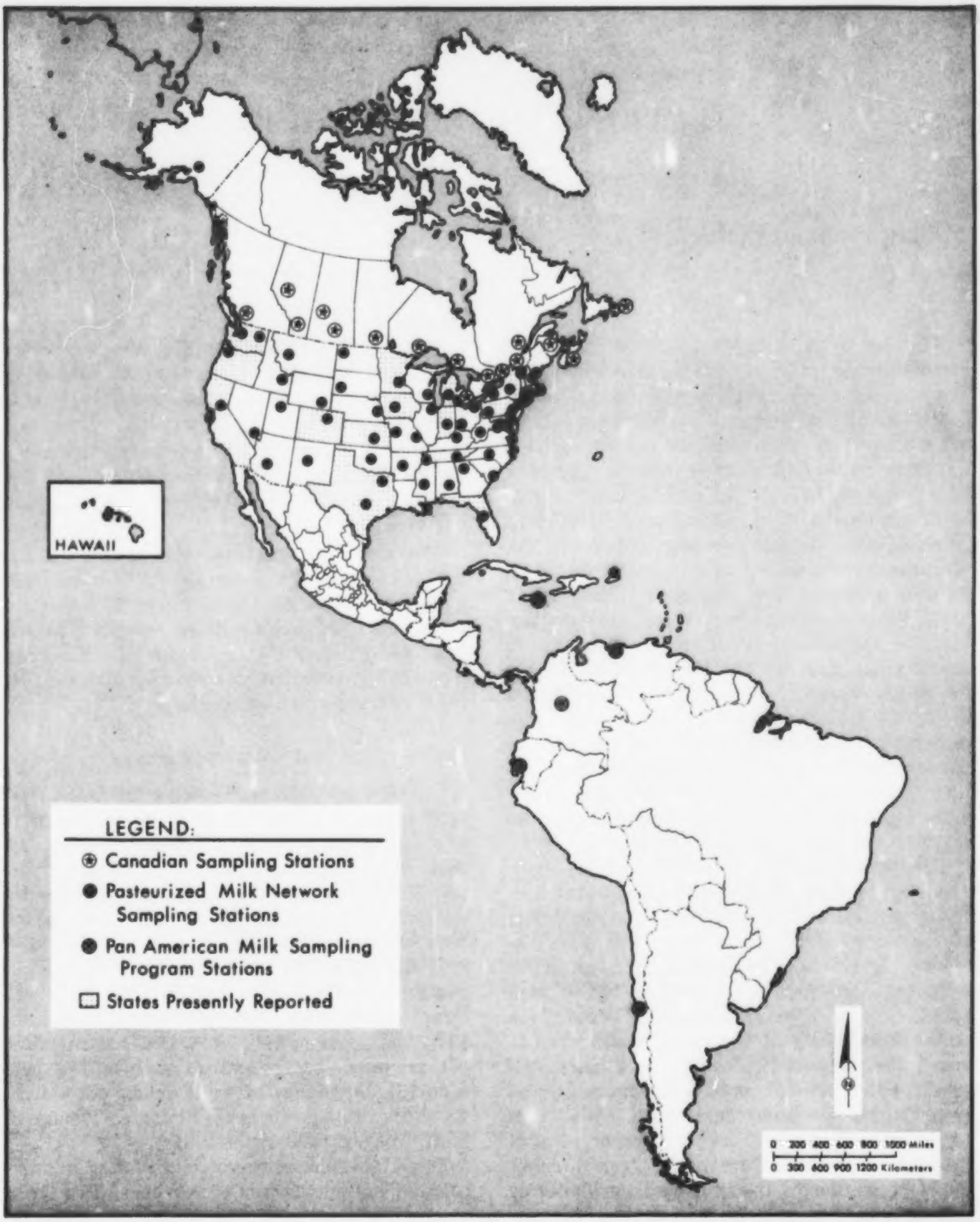
HAWAII
LEGEND:
⊛ Canadian Sampling Stations
● Pasteurized Milk Network Sampling Stations
● Pan American Milk Sampling Program Stations
☐ States Presently Reported
0 200 400 600 800 1000 Miles
0 300 600 900 1200 Kilometers

Figure 1. Milk sampling networks in the Western Hemisphere

strontium and radiocesium, respectively). The contents of both calcium and potassium in milk have been measured extensively and are relatively constant. Appropriate values and their variations, expressed in terms of 2 standard deviations (2σ), for these elements are 1.16 ± 0.08 g/liter for calcium and 1.51 ± 0.21 g/liter for potassium. These figures are averages of data from the PMN for May 1963-March 1966 (*3*) and are used for general radiation calculations.

Accuracy of data from various milk networks

In order to combine data from the international, national, and State networks considered in this report, it was first necessary to determine the accuracy with which each laboratory is making its determination and the agreement of the measurements among the laboratories. The Analytical Quality Control Service of the Office of Radiation Programs conducts periodic studies to assess the accuracy of determinations of radionuclides in milk performed by interested radiochemical laboratories. The generalized procedure for making such a study has been outlined previously (*4*).

The most recent study was conducted during July 1971 with 37 laboratories participating in an experiment on a milk sample containing known concentrations of iodine-131, cesium-137, strontium-89, and strontium-90 (*5*). Of the 17 laboratories producing data for the networks reporting in *Radiation Data and Reports*, 14 participated in the experiment.

The accuracy results of this experiment for these 14 laboratories are shown in table 1. Considerable improvement has been made in the accuracy of the analyses of all radionuclides compared to the results of previous studies. Some improvement is still needed in the technique for determining the strontium-90 results. These possible differences should be kept in mind when considering the integration of data from the various networks.

Development of a common reporting basis

Since the various networks collect and analyze samples differently, a complete understanding of several parameters is useful for interpreting the data. Therefore, the various milk surveillance networks that report regularly were surveyed for information on analytical methods, sampling and analysis frequencies, and estimated analytical errors associated with the data.

In general, radiostrontium is collected by an ion-exchange technique and determined by beta-particle counting in low-background detectors, and the gamma-ray emitters (potassium-40, iodine-131, cesium-137, and barium-140) are determined by gamma-ray spectroscopy of whole milk. Each laboratory has its own modifications and refinements of these basic methodologies.

Many networks collect and analyze samples on a monthly basis. Some collect samples more frequently but composite the several samples for one analysis, while others carry out their analyses more often than once a month. Many networks are analyzing composite samples on a quarterly basis for certain nuclides. The frequency of collection and analysis varies not only among the networks but also at different stations within some of the networks. In addition, the frequency of collection and analysis is a function of current environmental levels. The number of samples analyzed at a particular sampling station under current conditions is

Table 1. Distribution of mean results, quality control experiment

Isotope and known concentration	Number of laboratories in each category				Experimental 2σ error (pCi/liter)
	Acceptable[a]	Warning level[b]	Unacceptable[c]	Total	
Iodine-131 (69 pCi/liter)	13 (100%)	0	0	13	6
Cesium-137 (52 pCi/liter)	12 (92%)	1 (8%)	0	13	6
Strontium-89 (31 pCi/liter)	9 (90%)	1 (10%)	0	10	6
Strontium-90 (41.6 pCi/liter)	9 (69%)	1 (8%)	3 (23%)	13	2.4

[a] Measured concentration equal to or within 2σ of the known concentration.
[b] Measured concentration outside 2σ and equal to or within 3σ of the known concentration.
[c] Measured concentration outside 3σ of the known concentration.

reflected in the data presentation. Current levels for strontium-90 and cesium-137 are relatively stable over short periods of time, and sampling frequency is not critical. For the short-lived radionuclides, particularly iodine-131, the frequency of analysis is critical and is generally increased at the first measurement or recognition of a new influx of this radionuclide.

The data in table 2 shows whether raw or pasteurized milk was collected. An analysis (*7*) of raw and pasteurized milk samples collected during January 1964 to June 1966 indicated that for relatively similar milkshed or sampling areas, the differences in concentration of radionuclides in raw and pasteurized milk are not statistically significant (*7*). Particular attention was paid to strontium-90 and cesium-137 in that analysis.

Practical reporting levels were developed by the participating networks, most often based on 2-standard-deviation counting errors or 2-standard-deviation total analytical errors from replicate analyses (*3*). The practical reporting level reflects analytical factors other than statistical radioactivity counting variations and will be used as a practical basis for reporting data.

The following practical reporting levels have been selected for use by all networks whose practical reporting levels were given as equal to or less than the given value.

Radionuclide	Practical reporting level (pCi/liter)
Strontium-89	5
Strontium-90	2
Iodine-131	10
Cesium-137	10
Barium-140	10

Some of the networks gave practical reporting levels greater than those above. In these cases the larger value is used so that only data considered by the network as meaningful will be presented. The practical reporting levels apply to the handling of individual sample determinations. The treatment of measurements equal to or below these practical reporting levels for calculation purposes, particularly in calculating monthly averages, is discussed in the data presentation.

Analytical error or precision expressed as pCi/liter or percent in a given concentration range has also been reported by the networks (*3*). The precision errors reported for each of the radionuclides fall in the following ranges:

Radionuclide	Analytical errors of precision (2 standard deviations)
Strontium-89	1–5 pCi/liter for levels <50 pCi/liter; 5–10% for levels ≥50 pCi/liter;
Strontium-90	1–2 pCi/liter for levels <20 pCi/liter; 4–10% for levels ≥20 pCi/liter;
Iodine-131 Cesium-137 Barium-140	4–10 pCi/liter for levels <100 pCi/liter; 4–10% for levels ≥100 pCi/liter.

For iodine-131, cesium-137, and barium-140, there is one exception for these precision error ranges: 25 pCi/liter at levels <100 pCi/liter for Colorado. This is reflected in the practical reporting level for the Colorado milk network.

Federal Radiation Council guidance applicable to milk surveillance

In order to place the U.S. data on radioactivity in milk presented in *Radiation Data and Reports* in perspective, a summary of the guidance provided by the Federal Radiation Council for specific environmental conditions was presented in the December 1970 issue of *Radiological Health Data and Reports.*

Data reporting format

Table 2 presents the integrated results of the international, national, and State networks discussed earlier. Column 1 lists all the stations which are routinely reported to *Radiation Data and Reports*. The relationship between the PMN stations and the State stations is shown in figure 2. The first column in table 2 under each of the reported radionuclides gives the monthly average for the station and the number of samples analyzed in that month in parentheses. When an individual sampling result is equal to or below the practical reporting level for the radionuclide, a value of zero is used for

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Table 2. Concentrations of radionuclides in milk for May 1972 and 12-month period June 1971 through May 1972

Sampling location		Type of sample[a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average[b]	12-month average	Monthly average[b]	12-month average
UNITED STATES:						
Ala:	Montgomery[c]	P	NA	7	16	9
Alaska:	Palmer[c]	P	4	5	0	11
Ariz:	Phoenix[c]	P	NA	0	0	0
Ark:	Little Rock[c]	P	NA	12	0	10
Calif:	Sacramento[c]	P	NA	1	0	0
	San Francisco[c]	P	NA	3	0	0
	Del Norte	P	12	11	11	9
	Fresno	P	3	2	0	5
	Humboldt	P	4	3	0	7
	Los Angeles	P	3	2	0	4
	Mendocino	P	5	5	0	6
	Sacramento	P	3	2	0	6
	San Diego	P	0	1	0	5
	Santa Clara	P	2	2	0	7
	Shasta	P	3	3	0	8
	Sonoma	P	4	2	0	7
Colo:	Denver[c]	P	NA	5	0	7
	East	R	(d)		NS	[e]0
	Northeast	R	(d)		NS	1
	Northwest	R	(d)		[e]0	[e]0
	South Central	R	(d)		NS	NS
	Southeast	R	(d)		NS	[e]0
	Southwest	R	(d)		[e]0	2
	West	R	(d)		[e]0	[e]0
Conn:	Hartford[c]	P	NA	6	0	8
	Central	P	5	7	15	14
Del:	Wilmington[c]	P	NA	8	13	5
D.C:	Washington[c]	P	NA	7	0	7
Fla:	Tampa[c]	P	5	5	41	41
	Central	R	3	5	37	43
	North	R	3	9	14	23
	Northeast	R	8	7	44	37
	Southeast	R	5	6	53	56
	Tampa Bay area	P	8	5	44	39
	West	R	10	10	20	19
Ga:	Atlanta[c]	P	NA	9	11	15
Hawaii:	Honolulu[c]	P	4	3	0	3
Idaho:	Idaho Falls[c]	P	4	5	0	0
Ill:	Chicago[c]	P	6	7	16	12
Ind:	Indianapolis[c]	P	NA	7	0	4
	Central	P	7	7	15	13
	Northeast	P	7	7	15	15
	Northwest	P	8	8	15	16
	Southeast	P	7	8	5	16
	Southwest	P	9	8	15	17
Iowa:	Des Moines[c]	P	NA	4	0	2
	Iowa City	P	6	7	23	11
	Des Moines	P	7	6	12 (2)	10
	Little Cedar	P	NS	7	NS	12
	Spencer	P	5	6	17	12
Kans:	Wichita[c]	P	NA	8	0	2
	Coffeyville	P	7	8	0	13
	Dodge City	P	4	5	14	10
	Falls City, Nebr	R	10	3	13	8
	Hays	P	4	10	0	9
	Kansas City	P	7	8	11	11
	Topeka	P	10	8	14	8
	Wichita	P	7	9	11	10
Ky:	Louisville[c]	P	NA	8	0	8
La:	New Orleans[c]	P	10	14	[illegible]	14
Maine:	Portland[c]	P	NA	7	22	21
Md:	Baltimore[c]	P	NA	8	0	5
Mass:	Boston[c]	P	7	7	15	11
Mich:	Detroit[c]	P	NA	7	15	11
	Grand Rapids[c]	P	NA	8	16	10
	Bay City	P	8	5	16 (2)	15
	Charlevoix	P	5	9	14 (4)	15
	Detroit	P	6	6	19	11
	Grand Rapids	P	5	6	13	9
	Lansing	P	4	7	15	16
	Marquette	P	7	8	24 (3)	24
	Monroe	P	4	3	0 (2)	4
	South Haven	P	4	6	12 (4)	10
Minn:	Minneapolis[c]	P	NA	8	17	17
	Bemidji	P	4	8	19	19
	Duluth	P	15	16	23	29
	Fergus Falls	P	6	8	16	17
	Little Falls	P	16	16	30	30
	Mankato	P	6	6	11	11
	Minneapolis	P	10	12	20	17

Footnotes at end of table.

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Table 2. Concentrations of radionuclides in milk for May 1972 and 12-month period June 1971 through May 1972—continued

Sampling location		Type of sample[a]	Radionuclide concentration (pCi/liter)			
			Strontium-90		Cesium-137	
			Monthly average[b]	12-month average	Monthly average[b]	12-month average
UNITED STATES:—continued						
Minn:	Rochester	P	7	8	14	14
	Worthington	P	4	6	11	12
Miss:	Jackson[c]	P	NA	12	15	11
Mo:	Kansas City[c]	P	NA	8	0	6
	St. Louis[c]	P	NA	5	0	5
Mont:	Helena[c]	P	NA	6	0	8
Nebr:	Omaha[c]	P	NA	7	0	3
Nev:	Las Vegas[c]	P	NA	2	0	1
N.H:	Manchester[c]	P	NA	8	18	18
N.J:	Trenton[c]	P	NA	7	0	8
N. Mex:	Albuquerque[c]	P	NA	3	0	0
N.Y:	Buffalo[c]	P	6	7	14	7
	New York City[c]	P	NA	7	14	10
	Syracuse[c]	P	NA	7	13	8
	Albany	P	6	6	[d]0	[d]0
	Buffalo	P	NS	NS	[d]0	[d]0
	Massena	P	13	8	11	[d]0
	New York City	P	5	6	13	[d]0
	Syracuse	P	9	5	[d]0	[d]0
N.C:	Charlotte[c]	P	NA	11	0	11
N. Dak:	Minot[c]	P	NA	9	15	14
Ohio:	Cincinnati[c]	P	NA	6	15	4
	Cleveland[c]	P	NA	7	19	7
Okla:	Oklahoma City[c]	P	NA	7	13	8
Oreg:	Portland[c]	P	5	5	12	6
	Baker	P	NA		0	0
	Coos Bay	P	NA		0	3
	Eugene	P	NA		0	2
	Medford	P	NA		0	4
	Portland composite	P	NA		0	9
	Portland local	P	NA		0	11
	Redmond	P	NA		0	0
	Tillamook	P	NA		0	13
Pa:	Philadelphia[c]	P	NA	7	14	5
	Pittsburgh[c]	P	NA	10	13	8
	Dauphin	P	4	7	22	13
	Erie	P	0	7	8	13
	Philadelphia	P	5	4	13	14
	Pittsburgh	P	8	6	19	15
R.I:	Providence[c]	P	NA	8	15	12
S.C:	Charleston[c]	P	8	9	0	15
S. Dak:	Rapid City[c]	P	NA	6	12	7
Tenn:	Chattanooga[c]	P	NA	8	18	11
	Memphis[c]	P	NA	7	0	5
	Chattanooga	P	10	10	0	12
	Clinton	R	8	9	16 (2)	15
	Fayetteville	P	10	9	7 (2)	6
	Kingston	R	12	9	6 (2)	11
	Knoxville	P	8	8	0 (2)	10
	Lawrenceburg	R	8	8	17	9
	Nashville	P	8	8	14	9
	Pulaski	R	5	8	10 (2)	7
	Sequoyah	R	8	8	14	19
Tex:	Austin[c]	P	NA	1	0	0
	Dallas[c]	P	NA	6	0	2
	Amarillo	R	NA		NA	
	Corpus Christi	R	NA		NA	
	El Paso	R	NA		NA	
	Fort Worth	R	NA		NA	
	Harlingen	R	NA		NA	
	Houston	R	NA		NA	
	Lubbock	R	NA		NA	
	Midland	R	NA		NA	
	San Antonio	R	NA		NA	
	Texarkana	R	NA		NA	
	Uvalde	R	NA		NA	
	Wichita Falls	R	NA		NA	
Utah:	Salt Lake City[c]	P	0	5	0	8
Vt:	Burlington[c]	P	NA	5	16	12
Va:	Norfolk[c]	P	NA	8	15	7
Wash:	Seattle[c]	P	NA	4	0	6
	Spokane[c]	P	NA	6	15	9
	Benton County	R	0	1	0	0
	Franklin County	R	NS	1	NS	4
	Longview[g]	R	8		0	
	Sandpoint, Idaho	R	9	12	0	0
	Skagit County	R	10	8	0	0
W. Va:	Charleston[c]	P	NA	8	0	5
Wisc:	Milwaukee[c]	P	NA	6	14	5
Wyo:	Laramie[c]	P	NA	8	0	2

Footnotes at end of table.

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Table 2. Concentrations of radionuclides in milk for May 1972 and 12-month period June 1971 through May 1972—continued

Sampling location	Type of sample[a]	Radionuclide concentration (pCi/liter)			
		Strontium-90		Cesium-137	
		Monthly average[b]	12-month average	Monthly average[b]	12-month average
CANADA:					
Alberta: Calgary	P	NA		19	19
Edmonton	P	NA		22	24
British Columbia:					
Vancouver	P	NA		19	26
Manitoba: Winnipeg	P	NA		20	23
New Brunswick:					
Fredericton	P	NA		21	21
Newfoundland:					
St. John's	P	NA		18	31
Nova Scotia:					
Halifax	P	NA		21	25
Ontario: Ottawa	P	NA		11	13
Sault Ste. Marie	P	NA		24	31
Thunder Bay	P	NA		28	26
Toronto	P	NA		NS	
Windsor	P	NA		7	10
Quebec: Montreal	P	NA		11	16
Quebec	P	NA		26	23
Saskatchewan:					
Regina	P	NA		19	17
Saskatoon	P	NA		16	19
CENTRAL AND SOUTH AMERICA:					
Canal Zone:					
Cristobal[c]	P	NA	0	21	6
Chile: Santiago	P	0	0	0	2
Colombia: Bogota	P	0	1	0	0
Ecuador: Guayaquil	P	0	0	0	0
Jamaica: Mandeville	P	3	4	40	64
Puerto Rico:					
San Juan[c]	P	NA	3	13	8
Venezuela: Caracas	P	0	0	0	0
PMN network average[f]		5	6	8	8

[a] P, Pasteurized milk.
R, Raw milk.

[b] When an individual sampling result was equal to or less than the practical reporting level, a value of "0" was used for averaging. Monthly averages less than the practical reporting level reflect the fact that some but not all of the individual samples making up the average contained levels greater than the practical reporting level. When more than one analysis was made in a monthly period, the number of samples in the monthly average is given in parentheses.

[c] Pasteurized Milk Network station. All other sampling locations are part of the State or National network.

[d] Radionuclide analysis not routinely performed.

[e] The practical reporting levels for these networks differ from the general ones given in the text. Sampling results for the networks were equal to or less than the following practical reporting levels:

Iodine-131:	Colorado—25 pCi/liter	Cesium-137:	Colorado—25 pCi/liter	Strontium-90:	New York—3 pCi/liter
	Michigan—14 pCi/liter		New York—20 pCi/liter		
	Oregon—15 pCi/liter		Oregon—15 pCi/liter		

[f] This entry gives the average radionuclide concentrations for the PMN stations denoted by footnote [c].

[g] New station added May 1972 as part of Trojan Nuclear Power Plant preoperational surveillance.

NA, no analysis.
NS, no sample collected.

averaging. Monthly averages are calculated using the above convention. Averages which are equal to or less than the practical reporting levels reflect the presence of radioactivity in some of the individual samples greater than the practical reporting level.

The second column under each of the radionuclides reported gives the 12-month average for the station as calculated from the preceding 12 monthly averages, giving each monthly average equal weight. Since the daily intake of radioactivity by exposed population groups, averaged over a year, constitutes an appropriate criterion for the case where the FRC radiation protection guides apply, the 12-month average serves as a basis for comparison.

Discussion of current data

In table 2, surveillance results are given for strontium-90 and cesium-137 for May 1972 and the 12-month period, June 1971 to May 1972. Except where noted, the monthly average rep-

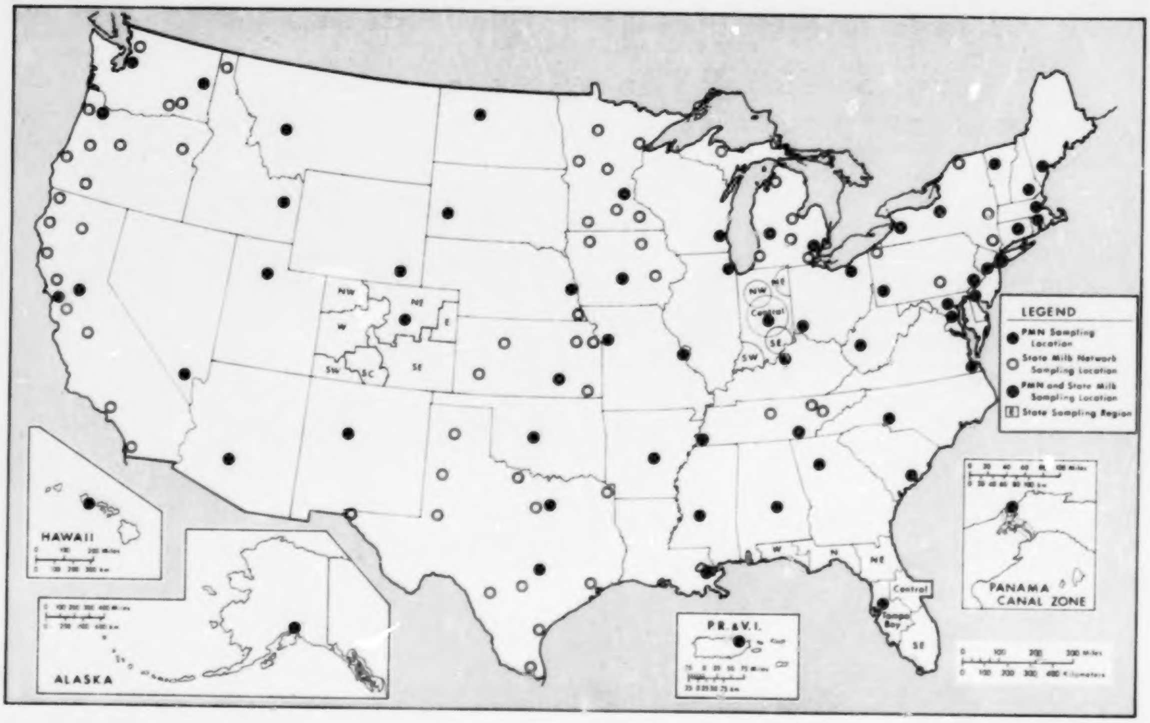
LEGEND
● PMN Sampling Location
○ State Milk Network Sampling Location
● PMN and State Milk Sampling Location
E State Sampling Region
HAWAII
ALASKA
PR.&V.I.
PANAMA CANAL ZONE
NW
NE
W
E
SW
SC
SE
Central
N
Tampa Bay

Figure 2. State and PMN milk sampling stations in the United States

resents a single sample for the sampling station. Strontium-89, iodine-131, and barium-140 data have been omitted from table 2 since levels at the great majority of the stations for May 1972 were below the respective practical reporting levels. Table 3 gives monthly averages for these stations at which strontium-89, iodine-131, and barium-140 were detected.

Strontium-90 monthly averages ranged from 0 to 16 pCi/liter in the United States for May 1972, and the highest 12-month average was 16 pCi/liter (Duluth, Little Falls, Minn.) representing 8.0 percent of the Federal Radiation Council radiation protection guide. Cesium-137 monthly averages ranged from 0 to 53 pCi/liter in the United States for May 1972, and the highest 12-month average was 56 pCi/liter (Southeast, Fla.) representing 1.6 percent of the value derived from the recommendations given in the Federal Radiation Council report. Of particular interest are the consistently higher cesium-137 levels that have been observed in Florida (*8*) and Jamaica.

Table 3. Strontium-89, iodine-131, and barium-140 in milk, May 1972

Sampling location		Concentration (pCi/liter)		
		Strontium-89	Iodine-131	Barium-140
Calif:	Del Norte (State)	5		
Colo:	Northwest (State)			29
Kans:	Coffeyville (State)	7		11
	Dodge City (State)	5		
	Hays (State)	5		
	Kansas City (State)	7	10	15
La:	New Orleans (PMN)	11		
Tenn:	Clinton (State)	6		
	Fayetteville (State)	6		
	Nashville (State)		12	

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Radiation Protection Division
Canadian Department of National
Health and Welfare

Radiological Health Section
Division of Occupational and Radiological
Health
Colorado Department of Health

Radiological Health Services
Division of Medical Services
Connecticut State Department of Health

Radiological and Occupational Health Section
Department of Health and Rehabilitative
Services
State of Florida

Bureau of Environmental Sanitation
Division of Sanitary Engineering
Indiana State Board of Health

Division of Radiological Health
Environmental Engineering Services
Iowa State Department of Health

Radiation Control Section
Environmental Health Division
Kansas State Department of Health

Radiological Health Services
Division of Occupational Health
Michigan Department of Health

Radiation Control Section
Division of Environmental Health
State of Minnesota Department of Health

Bureau of Radiological Pollution Control
New York State Department of Environmental
Conservation

Environmental Radiation Surveillance Program
Division of Sanitation and Engineering
Oregon State Board of Health

Radiological Health Section
Bureau of Environmental Health
Pennsylvania Department of Public Health

Radiological Health Services
Division of Preventable Diseases
Tennessee Department of Public Health

Division of Occupational Health
Environmental Health Services
Texas State Department of Health

Radiation Control Section
Division of Health
Washington Department of Social and
Health Services

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Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates, along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides. Programs reported in *Radiation Data and Reports* are as follows:

Program	Period reported	Issue
California Diet Study	July-December 1970	November 1971
Carbon-14 in Total Diet and Milk	July-December 1971	May 1972
Connecticut Standard Diet	January-December 1970	December 1971
Institutional Total Diet	October-December 1971 and 1971 Annual Summary	June 1972
Radiostrontium in Milk	January-December 1970	April 1972
Strontium-90 in Tri-City Diets	January-December 1970	November 1971

Section II. Water

The Environmental Protection Agency and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2-4*) set the limits for approval of a drinking water supply containing radium-226 and strontium-90 at 3 pCi/liter and 10 pCi/liter, respectively. Higher concentrations may be acceptable if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence[1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity, except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities reported in *Radiation Data and Reports* are listed below.

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[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90, respectively.

Water sampling program	Period reported	Issue
Colorado River Basin	1968	March 1972
Interstate Carrier Drinking Water	1971	May 1972
Kansas	January-December 1970	December 1971
Michigan	January-June 1970	November 1971
North Carolina	January-December 1967	May 1969
Radioactivity in Florida Waters	1969	January 1972
Radiostrontium in Tap Water, *HASL*	January-June 1971	April 1972
Tritium in Community Water Supplies	1969	December 1970
Tritium Surveillance System	January-March 1972	August 1972
Washington	July 1969-June 1970	March 1972
New York	July-December 1970 and January-June 1971	May 1972
Radioactivity in California Waters	January-December 1970	June 1972

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Gross Radioactivity in Surface Waters of the United States, January 1972

Office of Water Programs
U.S. Environmental Protection Agency

The monitoring of gross radioactivity in surface waters of the United States was initiated in 1957 as part of the Water Pollution Surveillance System (formerly National Water Quality Network) of the U.S. Public Health Service. Currently, the program is operated by the U.S. Environmental Protection Agency, Office of Water Programs. Regional offices of the Environmental Protection Agency are responsible for the collection of samples and the entering of the resulting data into the analytical storage and retrieval system. Radioactivity analyses are performed in the centralized radioactivity laboratories of the Office of Water Programs (Cincinnati, Ohio).

The regular reporting of gross radioactivity data in *Radiological Health Data and Reports* was terminated with the publication of data for October 1968 (April 1969 issue). With the publication of data for January 1971, this activity was resumed as a monthly report series. The unpublished data for the time interval of November 1968 through December 1970 will be the subject of a future summary article.

Table 1 presents the gross alpha and beta radioactivity results for samples collected from 11 rivers during January 1972. The analytical procedures used for determining gross alpha and beta radioactivity are described in the 13th Edition of *Standard Methods for the Examination of Water and Wastewater* (1). Results are reported for the date of counting and are not corrected to the date of collection. The sensitivity in counting is that defined by the National Bureau of Standards, Handbook 86 (2) and is calculated to be <0.2 pCi/liter for gross alpha radioactivity and <1 pCi/liter for gross beta radioactivity measurements.

REFERENCES

(*1*) AMERICAN PUBLIC HEALTH ASSOCIATION: AMERICAN WATER WORKS ASSOCIATION AND WATER POLLUTION CONTROL FEDERATION. Standard methods for the examination of water and wastewater, 13th edition, New York, N.Y. (1971).

(*2*) U.S. DEPARTMENT OF COMMERCE. Radioactivity, Recommendations of the International Commission on Radiological Units and Measurements (1962), NBS Handbook 86 (November 29, 1963).

Table 1. Gross radioactivity in U.S. surface waters, January 1972

River and station	Number of grab samples	Gross alpha radioactivity (pCi/liter)		Gross beta radioactivity (pCi/liter)	
		Suspended solids	Dissolved solids	Suspended solids	Dissolved solids
Cl'nch River:					
Kingston, Tenn	[a] 4	<0.5 (<0.3,0.8)	<0.6 (<0.4,1.0)	<3 (<2,4)	5 (4,8)
Colorado River:					
DeBeque, Colo	1	.6	3.0	3	12
Above Moab, Utah	4	5.8 (1.5,6.0)	11.5 (7.0,17.1)	18 (6,23)	21 (16,26)
Below Moab, Utah	4	1.3 (.7,2.2)	8.4 (7.1,9.1)	9 (5,16)	15 (12,24)
Silt, Colo	1	.3	3.2	<2	12
Dolores River:					
Bedrock, Colo	4	4.3 (2.1,7.1)	7.0 (6.4,8.3)	14 (8,19)	13 (9,18)
Gateway, Colo	4	3.4 (1.9,5.5)	21.9 (12.3,26.8)	12 (10,14)	102 (81,118)
Green River:					
LaBarge, Wyo	2	.5 (.5, .6)	1.6 (1.1,2.1)	<2 (<2, <2)	4 (3,5)
Mississippi River:					
Burlington, Iowa	1	.4	3.3	<2	10
Ohio River:					
Cincinnati, Ohio	4	3.2 (1.1,6.4)	<.6 (<.5, .8)	11 (2,20)	4 (2,6)
Roanoke River:					
John Kerr Dam, Va	5	<.4 (<.3, .7)	<.4 (<.3, .5)	<2 (<2,4)	3 (2,4)
San Juan River:					
Bluff, Utah	1	9.4	1.7	31	13
San Miguel River:					
Naturita, Colo	4	<.5 (< .4, .6)	4.0 (2.5,6.5)	<3 (<2,5)	10 (6,13)
Uravan, Colo	4	<.4 (<.3, .5)	<3.0 (<2.1,3.8)	<2 (<2,3)	9 (7,13)
Below Uravan, Colo	4	<2.9 (<.4,8.9)	26.2 (15.7,39.3)	10 (5,23)	50 (41,60)
Susquehanna River:					
Holtwood, Penna	1	.6	.6	<2	<2
Conowingo, Md	2	<.3 (<.3, .3)	<.3 (<.2, <.5)	<2 (<2, <2)	2 (2,2)
St. Lawrence River:					
Massena, N.Y	5	<.4 (<.3, .4)	1.3 (.9,1.9)	<2 (<2, <2)	6 (4,10)

[a] Where more than one sample is analyzed during the month, the minimum and maximum are in parentheses.

Radioactivity in North Carolina Surface, Cistern, and Saline Waters, 1968–1970[1]

Sanitary Engineering Division
Radiological Health Section
North Carolina State Board of Health

The North Carolina State Board of Health maintains an Environmental Radiation Surveillance Network to monitor radioactivity in selected media throughout the State. The Program is administered by the Radiological Health Section of the Sanitary Engineering Division. Sample analysis is provided by the Environmental Sciences Section of the Laboratory Division. The Public Health Statistics Section of the Epidemiology Division provides assistance in certain data processing activity, while computer services are obtained through the Systems Management Division of the Department of Administration. Environmental sample collection is performed primarily by the staffs of municipalities and local health departments.

The program started with the surveillance of 147 sources of untreated surface waters. These supplies were selected as being representative of water quality in the many river basins of the State. Sample collection was achieved through close cooperation with municipalities and local health departments.

The program has changed through the years as technological advances in instrumentation made it possible to monitor more facets of the environment. In July 1962, cistern water samples from Ocrocoke Island were added to the surveillance program. In January 1963, airborne particulates, rainfall, and dustfall samples were collected on a routine sampling schedule over the State. The surface water program was modified to include treated water assays.

Surface water

Grab samples of both treated and untreated surface water are taken on a monthly basis at nine water treatment plants. These stations were selected to obtain samples from the State's major drainage districts with the French-Broad, Catawba, Yadkin, Cape Fear, Neuse, and Tar-Pamlico river basins being represented.

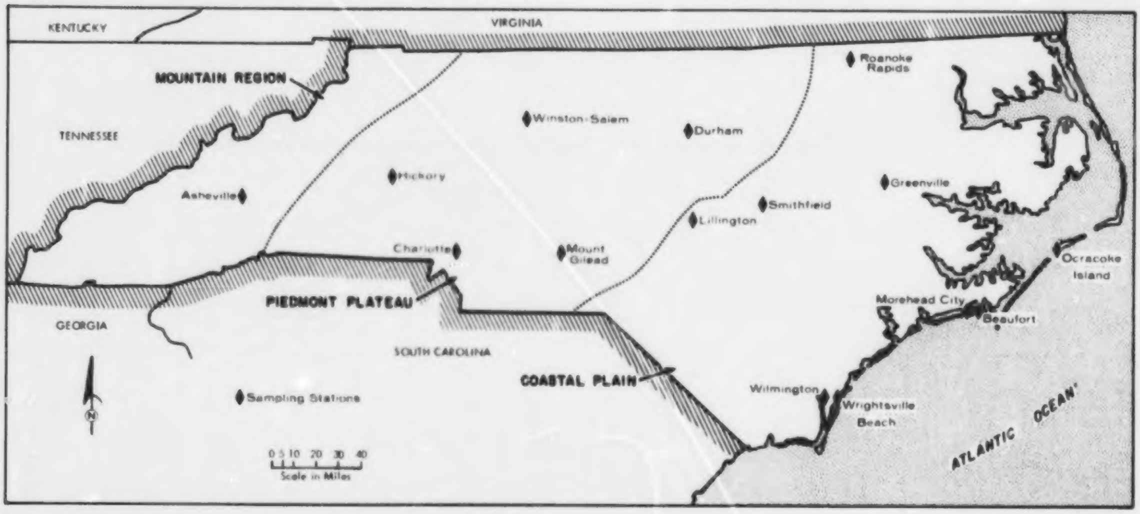
KENTUCKY
VIRGINIA
MOUNTAIN REGION
TENNESSEE
Roanoke Rapids
Winston-Salem
Durham
Hickory
Asheville
Greenville
Smithfield
Lillington
Charlotte
Mount Gilead
Ocracoke Island
PIEDMONT PLATEAU
GEORGIA
Morehead City
Beaufort
SOUTH CAROLINA
COASTAL PLAIN
Wilmington
Wrightsville Beach
Sampling Stations
N
ATLANTIC OCEAN
0 5 10 20 30 40
Scale in Miles

Figure 1. North Carolina water sampling stations, 1968–1970

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[1] Summarized from "Environmental Radiation Surveillance in North Carolina, 1968–1970."

The samples are routinely collected in 1 gallon (polyethylene) containers by the water plant operator or chemist and mailed to the State laboratory for analysis. Additional samples can be collected as needed. These stations are shown in figure 1.

Untreated water samples are acidified with hydrochloric acid to prevent loss of activity through precipitation and/or adhesion. The samples are then transferred to 3½-liter polyethylene Marinelli beakers for gamma scans.

After scanning, 1 liter is filtered through Whatman No. 12 folded filter paper. The filter paper, containing the suspended solids, is ashed in a muffled furnace at 600 degrees Centigrade. The residue is then transferred to a tared planchet, dried, weighed, and submitted for gross alpha and beta counting (*1*).

The filtrate is separted by precipitation into dissolved sulfates and dissolved carbonates, plancheted, and submitted for gross beta counting (*1*).

As with the untreated surface water, treated water samples are acidified with 2 milliliters of hydrochloric acid to prevent loss of activity through precipitation and adhesion. These samples are transferred to 3½-liter polyethylene Marinelli beakers for gamma scans. The suspended material is prepared for gross alpha and beta counting in the same manner as untreated water samples. The filtrate is carefully evaporated to determine the gross alpha and beta activity of the dissolved solids. As before, if the total gross beta is greater than 5 pCi/liter, a strontium-89 and strontium-90 determination is performed.

Table 1. Gross beta radioactivity in North Carolina raw surface water, 1968–1970

Location	Concentration (pCi/liter)											
	1968				1969				1970			
	Number of samples	Maximum	Minimum	Average	Number of samples	Maximum	Minimum	Average	Number of samples	Maximum	Minimum	Average
Asheville	10	3.0	<3.0	<3.0	10	3.4	<3.0	<3.0	14	<3.0	<3.0	<3.0
Charlotte	9	5.2	<3.0	3.12	12	3.2	<3.0	<3.0	13	11.6	<3.0	<3.0
Greenville	8	7.3	4.5	5.42	10	6.1	3.7	4.61	12	9.5	3.3	5.27
Hickory	10	10.7	<3.0	3.81	11	3.4	<3.0	<3.0	11	3.7	<3.0	<3.0
Lillington	10	9.7	3.7	6.17	12	7.6	3.0	5.69	12	15.3	4.5	7.36
Mt. Gilead	NS				10	4.1	<3.0	<3.0	13	5.6	<3.0	3.43
Roanoke Rapids	NS				10	4.5	<3.0	3.31	13	4.3	<3.0	3.72
Smithfield	11	9.1	4.1	6.08	11	8.3	3.1	5.72	12	7.3	3.4	5.74
Wilmington	11	9.2	4.3	5.40	12	6.4	<3.0	4.63	14	9.0	3.3	5.20
Winston-Salem	11	3.7	<3.0	<3.0	12	5.7	<3.0	3.12	12	5.1	<3.0	3.16

NS, no sample.

Table 2. Gross beta radioactivity in North Carolina treated surface water, 1968–1970

Location	Concentration (pCi/liter)											
	1968				1969				1970			
	Number of samples	Maximum	Minimum	Average	Number of samples	Maximum	Minimum	Average	Number of samples	Maximum	Minimum	Average
Asheville	11	3.5	<3.0	<3.0	11	<3.0	<3.0	<3.0	14	<3.0	<3.0	<3.0
Charlotte	10	3.8	<3.0	<3.0	12	3.3	<3.0	<3.0	12	3.2	<3.0	<3.0
Greenville	8	4.8	3.5	4.18	11	5.0	3.1	3.88	12	5.8	<3.0	3.98
Hickory	10	5.5	<3.0	<3.0	10	<3.0	<3.0	<3.0	11	5.0	<3.0	<3.0
Lillington	11	7.6	3.2	5.06	12	8.4	<3.0	4.32	12	7.4	<3.0	4.12
Mt. Gilead	NS				10	4.8	<3.0	<3.0	13	3.9	<3.0	<3.0
Roanoke Rapids	NS				10	3.7	<3.0	<3.0	13	4.2	<3.0	3.34
Smithfield	10	9.3	3.2	4.88	12	6.1	<3.0	3.90	12	7.3	3.1	4.93
Wilmington	10	5.1	3.2	3.96	12	4.6	<3.0	<3.0	13	4.9	<3.0	3.49
Winston-Salem	11	3.1	<3.0	<3.0	12	<3.0	<3.0	<3.0	12	<3.0	<3.0	<3.0

NS, no sample.

A summary of surface water data is provided in table 1 (untreated) and table 2 (treated).

Cistern water

A cistern supply that is used as a source of drinking water was sampled on a routine basis. The samples were collected in 1-liter polyethylene containers and shipped to the State laboratory for analysis. The sampling was discontinued after the January 1970 samples.

Samples were prepared in the same manner as untreated surface water. A data summary for cistern water is given in table 3 for samples taken on Ocracoke Island.

Sewage treatment plant effluent water

Samples are taken on a monthly basis at three sewage treatment plants. They are routinely collected by plant personnel in 1-gallon polyethylene containers and mailed to the State laboratory for analysis. Additional samples can be collected if needed. Samples are prepared in the same manner as untreated surface water.

A summary of sewage treatment plant effluent water data is provided in table 4.

Saline water

One gallon of saline water is collected and processed the same as the untreated surface samples. However, because of high solids content, only 200 milliliters is filtered for alpha and beta measurement. The gross alpha and beta radioactivity in saline water is shown in table 5.

Summary of results

All environmental radioactivity concentrations during 1968-1970 were well below the limits set for protection of the public's health. There were no significant or unexpected differences between these results and the 1967 results.

Detectable quantities of fission products were observed in many samples during the reporting period. Increases in fission product inventories correlated well with reported nuclear detonations.

Table 3. Gross alpha and beta radioactivity in cistern water Ocracoke Island, 1968–1970

Year	Gross alpha radioactivity (pCi/liter)				Gross beta radioactivity (pCi/liter)			
	Number of samples	Maximum	Minimum	Average	Number of samples	Maximum	Minimum	Average
1968	10	<1.0	<1.0	<1.0	10	122	6.4	28.2
1969	12	<1.0	<1.0	<1.0	12	13.3	<8.0	8.9
1970	1	<1.0	<1.0	<1.0	1	7.5	7.5	7.5

Table 4. Gross alpha and beta radioactivity in sewage treatment effluent water, North Carolina, 1968–1970

Year and location	Gross alpha radioactivity (pCi/liter)				Gross beta radioactivity (pCi/liter)			
	Number of samples	Maximum	Minimum	Average	Number of samples	Maximum	Minimum	Average
1968:								
Charlotte	4	1.3	<1.0	<1.1	4	12.4	9.7	11.2
Durham	5	1.2	<1.0	<1.1	5	39.7	10.8	24.1
Winston-Salem	6	1.4	<1.0	<1.0	6	64.0	9.5	42.3
1969:								
Charlotte	11	<1.0	<1.0	<1.0	11	18.6	6.2	10.8
Durham	9	<1.0	<1.0	<1.0	9	23.5	10.3	16.4
Winston-Salem	12	2.0	<1.0	<1.0	12	59.4	9.1	50.1
1970:								
Charlotte	11	<1.0	<1.0	<1.0	11	16.1	8.6	10.9
Durham	10	<1.0	<1.0	<1.0	10	19.9	9.6	14.1
Winston-Salem	11	2.2	<1.0	<1.0	11	59.8	44.2	51.9

Table 5. Gross alpha and beta radioactivity in saline water, North Carolina, 1968–1970

Year and location	Gross alpha radioactivity (pCi/liter)				Gross beta radioactivity (pCi/liter)			
	Number of samples	Maximum	Minimum	Average	Number of samples	Maximum	Minimum	Average
1968:								
Beaufort	2	12.8	<1.0	<6.9	2	225	167	196
Morehead City	4	18.1	<1.0	<6.6	4	302	143	215
Wrightsville	4	40.7	<1.0	<18.6	4	317	23.5	120
1969:								
Beaufort	1	3.4	3.4	3.4	1	408	408	408
Morehead City	6	8.2	<1.0	<2.2	6	379	63.6	267
Wrightsville	NS							
1970:								
Beaufort	1	<1.0	<1.0	<1.0	1	132	132	132
Morehead City	5	18.0	<1.0	<4.4	5	270	16.2	171
Wrightsville	NS							

NS, no sample.

The continued demonstration of the ability of the network to detect low levels of radioactivity ensures that higher levels which could affect public health will not go unnoticed.

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Results of Radiological Sampling from the Community Water Supply Study

Office of Radiation Programs and
Office of Water Programs Operations
Environmental Protection Agency

A study of community water supplies in eight geographically distributed Standard Metropolitan Statistical Areas[1] (SMSA), and the State of Vermont, (figure 1) was conducted during 1969 by the Bureau of Water Hygiene, PHS (now the Office of Water Programs Operations of EPA). The purpose of the Community Water Supply Study was to determine whether (a) the water in these selected areas met the U.S. Public Health Service Drinking Water Standards (*2*), (b) the water supply systems had facility deficiencies that might indicate or lead to potentially unsafe drinking water, and (c) the bacteriological surveillance programs met the established criteria for collection of the required number of bacteriological samples and for passing the bacteriological quality standard. This study included 969 water supply systems serving about 18.2 million people. The Office of Radiation Programs assisted in this study by performing the analyses for the radioactivity and evaluating the results for comparison with the PHS Drinking Water Standards.

Study areas

The State of Vermont is not a SMSA, but was included in the study at the request of the Commissioner of Health, with the concurrence of the Governor of Vermont. A total of 218 water supplies serving 307,200 people was surveyed. Most supplies in Vermont utilize mountain brooks and springs feeding directly into the distribution system without treatment.

The New York, New York SMSA covered the

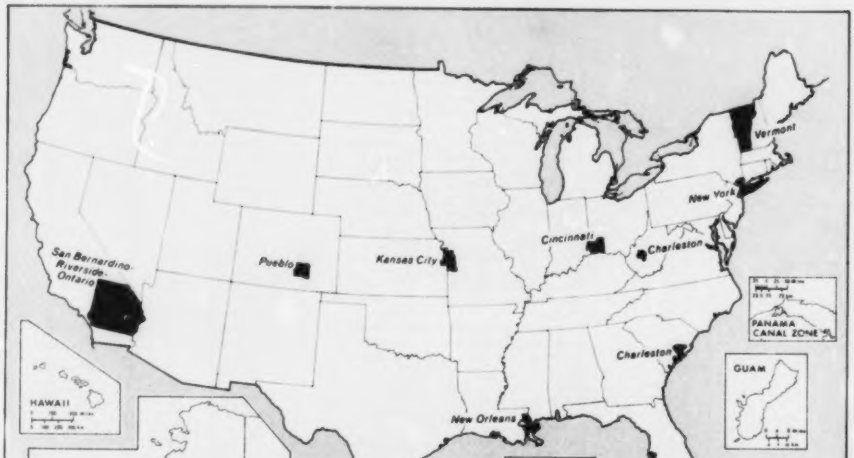

Figure 1. Selected Standard Metropolitan Statistical Areas (SMSA), and the State of Vermont

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[1] Standard Metropolitan Statistical Area—an area as defined by the Bureau of the Budget that contains at least one city of at least 50,000 inhabitants, or two cities with a combined population of at least 50,000. The area also includes the county of the central city, and adjacent counties that are found to be metropolitan in character and economically and socially integrated with the county of the central city (*1*).

Table 1. Radioactivity in community water supplies, 1969, State of Vermont

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
Vermont:								
Albany	8/1	Other	Finished	Ground	0	0		
Alburg	7/7	Distribution system	Finished	Surface	0	5		
Arlington	7/11	Distribution system	Finished	Ground	0	0		
	8/6	Distribution system	Finished	Other	0	0		
Ascutney	9/2	Distribution system	Partially treated	Combined	0	3		
Bakersfield	7/28	Reservoir	Raw	Ground	0	0		
Barnet	8/5	Distribution system	Finished	Ground	0	0		
Barre	7/9–7/23	Distribution system	Finished	Surface	0	0		
	8/26	Reservoir	Raw	Ground	0	0		
	8/26	Reservoir	Raw	Ground	0	3		
Barton	7/17	Distribution system	Finished	Surface	0	4		
Beebe Plain	7/30	Distribution system	Raw	Ground	0	4		
Beecher Falls	7/30	Well	Raw	Ground	0	0		
Bellow Falls	7/15	Distribution system	Finished	Surface	0	3		
	7/29	Distribution system	Raw	Ground	0	4		
Bennington	7/14	Distribution system	Finished	Ground	0	0		
	7/15–7/28	Reservoir	Finished	Combined	0	3		
	7/15	Reservoir	Partially treated	Surface	0	3		
Berlin	8/22	Distribution system	Finished	Ground	0	0		
Bethel	8/7	Distribution system	Finished	Ground	0	5		
Bloomfield	9/18	Distribution system	Other	Ground	0	0		
Bolton Valley	7/16	Distribution system	Raw	Ground	0	5		
	7/16	Reservoir	Raw	Surface	0	4		
Bradford	7/18	Distribution system	Partially treated	Surface	0	0		
Brandon	7/11	Reservoir	Raw	Surface	0	0		
	7/11	Well	Finished	Combined	0	3		
Brattleboro	7/14–7/28	Distribution system	Finished	Surface	0	4		
Bridgewater	8/25	Distribution system	Finished	Ground	0	5		
	8/25	Distribution system	Finished	Ground	0	3		
Bristol	7/11	Distribution system	Finished	Surface	0	3		
Burlington	7/8–7/22	Treatment plant	Finished	Surface	0	4		
Cabot	8/18	Distribution system	Raw	Ground	0	5		
Cady Falls	8/22	Distribution system	Other	Ground	0	0		
Cambridge	7/23	Distribution system	Finished	Ground	0	0		
Canaan	7/23	Distribution system	Raw	Ground	0	0		
	7/23	Well	Raw	Ground	0	7		
Castleton	7/28	Distribution system	Finished	Ground	0	0		
Cavendish	8/7	Well	Raw	Ground	5	6	0.0	
Center Rutland	7/31	Distribution system	Finished	Ground	0	0		
	7/31	Distribution system	Finished	Ground	0	0		
Chelsea	8/20	Well	Raw	Ground	0	7		
	8/20	Well	Raw	Ground	0	4		
Chester Depot	7/16	Well	Raw	Ground	0	5		
	7/15	Treatment plant	Raw	Surface	0	3		
Colchester	7/31	Treatment plant	Finished	Surface	0	3		
	8/4	Distribution system	Finished	Ground	7	4	.2	
	8/1	Treatment plant	Finished	Surface	0	7		
Concord	7/30	Distribution system	Raw	Ground	0	0		
Coventry	8/1	Distribution system	Finished	Surface	0	3		
Craftsbury	7/31	Other	Raw	Ground	0	0		
	7/31	Reservoir	Raw	Ground	0	10		
Cuttingsville	7/9	Distribution system	Finished	Ground	0	0		
Danby	7/29	Distribution system	Other	Ground	0	0		
Danville	7/11	Distribution system	Finished	Combined	0	0		
Derby Center	7/16	Other	Raw	Ground	0	5		
	7/16	Treatment plant	Finished	Surface	0	7		
Derby Line	7/17	Treatment plant	Finished	Surface	0	6		
Dorset	7/31	Distribution system	Finished	Ground	0	0		
Duxbury	8/26	Distribution system	Finished	Ground	0	0		
	8/26	Distribution system	Finished	Ground	0	0		
East Barnet	8/4	Distribution system	Finished	Other	0	0		
East Barre	10/29	Distribution system	Finished	Ground	4	6	0	
	8/19	Well	Raw	Ground	0	0		
East Berkshire	8/21	Reservoir	Raw	Ground	0	0		
East Braintree	7/17	Distribution system	Raw	Surface	0	0		
East Burke	8/20	Reservoir	Raw	Ground	0	3		
East Calais	8/29	Distribution system	Finished	Ground	0	0		
East Dorset	7/31	Distribution system	Finished	Ground	0	0		
East Fairfield	8/21	Well	Raw	Ground	0	3		
East Haven	7/31	Distribution system	Finished	Ground	0	4		
	7/31	Distribution system	Finished	Ground	0	5		
East Highgate	8/25	Distribution system	Finished	Ground	0	0		
East Middlebury	8/20	Other	Raw	Ground	0	0		
	8/20	Well	Raw	Ground	0	3		
	8/20	Well	Raw	Ground	0	0		
East Montpelier	8/18	Other	Raw	Ground	0	0		
East Ryegate	8/5	Reservoir	Raw	Ground	0	6		
Enosburg Falls	7/24	Distribution system	Finished	Ground	0	0		
Essex Center	8/7	Treatment plant	Finished	Surface	0	0		
Essex Junction	8/7	Other	Finished	Surface	0	0		
	8/8–8/21	Treatment plant	Finished	Surface	0	5		
	8/19	Treatment plant	Finished	Surface	0	5		
	7/18	Well	Finished	Ground	8	0		
Fairfax	8/4	Treatment plant	Finished	Surface	0	0		
Fair Haven	7/9	Other	Raw	Surface	0	8		
Fairlee	7/10	Treatment plant	Finished	Surface	0	4		

See footnotes at end of table.

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Table 1. Radioactivity in community water supplies, 1969, State of Vermont—continued

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter) Gross alpha	Gross beta	^{226}Ra	^{90}Sr
Vermont—continued								
Florence	8/4	Distribution system	Finished	Surface	0	0		
Franklin	8/4	Distribution system	Finished	Other	0	0		
Gilman	7/28	Other	Finished	Ground	0	0		
	7/28	Other	Finished	Ground	0	0		
Glover	8/4	Other	Raw	Ground	0	3		
Grand Isle	7/22	Distribution system	Finished	Surface	0	6		
Graniteville	8/26	Reservoir	Partially treated	Ground	0	0		
	8/26	Reservoir	Partially treated	Ground	0	3		
Greensboro	7/30	Distribution system	Finished	Combined	0	0		
	7/30	Treatment plant	Finished	Surface	0	4		
Greensboro Bend	7/30	Distribution system	Finished	Ground	0	0		
Guildhall	8/1	Distribution system	Finished	Surface	0	0		
Hardwick	7/16	Distribution system	Finished	Ground	0	0		
Hinesburg	8/7	Distribution system	Finished	Ground	0	0		
Huntington	7/14	Distribution system	Raw	Ground	0	0		
Huntington Center	7/14	Other	Raw	Surface	0	4		
Hyde Park	7/30	Distribution system	Raw	Ground	0	0		
Irasburg	7/31	Other	Raw	Ground	4	4	0.6	
Island Pond	7/17	Distribution system	Finished	Surface	0	3		
	7/17	Distribution system	Finished	Surface	0	3		
Jeffersonville	7/22	Distribution system	Finished	Ground	0	0		
	8/26	Distribution system	Finished	Surface	0	3		
Jericho	8/19	Treatment plant	Finished	Ground	0	0		
Jericho-Underhill	8/28	Other	Raw	Ground	0	4		
Johnson	7/15	Reservoir	Raw	Surface	0	5		
	7/15	Other	Raw	Ground	0	0		
Jonesville	8/18	Other	Raw	Ground	0	0		
Lake Elmore	8/21	Reservoir	Raw	Ground	0	0		
Ludlow	7/15	Treatment plant	Finished	Surface	0	0		
Lunenburg	7/28	Distribution system	Finished	Ground	0	0		
Lyndonville	7/11	Distribution system	Finished	Combined	0	6		
	8/6	Distribution system	Finished	Surface	0	6		
Mallets Bay	7/8	Distribution system	Finished	Ground	0	0		
Manchester Center	7/15	Distribution system	Finished	Surface	0	0		
	7/15	Distribution system	Finished	Combined	0	0		
Manchester	8/28	Distribution system	Other	Ground	0	4		
Marshfield	8/19	Distribution system	Finished	Ground	0	0		
	8/19	Distribution system	Finished	Ground	0	3		
Mechanicsville	8/7	Distribution system	Finished	Ground	0	0		
Mendon	8/1	Distribution system	Finished	Ground	0	0		
	9/17	Distribution system	Other	Ground	0	3		
	8/1	Distribution system	Other	Ground	0	0		
Middlebury	1/28/70	Distribution system	Raw	Combined	0	3		
	7/10	Well	Raw	Ground	0	0		
	7/10	Treatment plant	Raw	Ground	0	0		
Middlesex	8/26	Distribution system	Finished	Ground	0	0		
	8/26	Other	Other	Ground	0	0		
	8/26	Distribution system	Finished	Ground	0	0		
Milton	8/1	Distribution system	Finished	Surface	0	4		
	8/28	Distribution system	Finished	Ground	4	0	1.0	
	8/27	Distribution system	Raw	Ground	20	6	.8	
	8/28	Distribution system	Raw	Ground	4	3	0	
Montgomery	8/26	Distribution system	Other	Ground	0	0		
	8/26	Distribution system	Other	Combined	0	0		
	7/8	Distribution system	Finished	Surface	0	0		
Montpelier	7/16	Distribution system	Partially treated	Surface	0	0		
	8/21	Distribution system	Finished	Ground	0	0		
Morristown Corners	8/22	Other	Other	Ground	0	0		
Morrisville	7/29	Well	Raw	Ground	0	0		
Newbury	7/10	Treatment plant	Raw	Surface	0	0		
Newport	9/18	Other	Partially treated	Surface	0	4		
	9/18	Well	Raw	Ground	0	0		
Newport Center	7/29	Distribution system	Finished	Ground	0	0		
North Bennington	8/5	Treatment plant	Finished	Combined	0	3		
Northfield	7/17	Well	Finished	Ground	0	0		
North Hartland	7/22	Well	Raw	Ground	0	3		
North Hyde Park	8/22	Other	Raw	Ground	0	0		
North Montpelier	8/18	Distribution system	Raw	Ground	0	0		
North Pownal	7/17	Distribution system	Finished	Surface	0	0		
North Thetford	8/21	Distribution system	Finished	Ground	0	0		
	8/21	Other	Finished	Ground	0	4		
North Troy	7/15	Treatment plant	Finished	Surface	0	3		
North Westminster	7/22	Distribution system	Raw	Ground	0	0		
	7/22	Distribution system	Raw	Ground	0	3		
Norwich	7/15	Treatment plant	Finished	Surface	0	0		
Orleans	7/8	Treatment plant	Finished	Surface	0	3		
Passumpsic	8/5	Distribution system	Finished	Ground	0	0		
	8/5	Distribution system	Finished	Ground	0	8		
Peacham	8/5	Distribution system	Finished	Ground	0	0		
Pittsfield	9/17	Distribution system	Other	Ground	0	0		
Pittsford	7/30	Distribution system	Other	Ground	0	0		
Plainfield	8/19	Reservoir	Raw	Ground	0	6		
Poultney	7/9	Other	Raw	Combined	0	4		
	7/9	Well	Raw	Ground	0	0		
Pownal	7/15	Distribution system	Finished	Surface	0	0		
	8/20	Distribution system	Finished	Ground	0	0		

See footnotes at end of table.

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Table 1. Radioactivity in community water supplies, 1969, State of Vermont—continued

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
Vermont—continued								
Proctor	7/11	Well	Raw	Ground	0	0		
	7/11–7/24	Treatment plant	Finished	Surface	0	0		
Proctorsville	8/7	Well	Raw	Ground	0	3		
Putnamville	8/21	Distribution system	Finished	Ground	0	0		
Putney	7/29	Distribution system	Finished	Ground	0	0		
Quechee	7/14	Treatment plant	Finished	Ground	0	0		
Randolph	7/11	Other	Raw	Combined	0	0		
	7/14	Other	Raw	Combined	0	3		
Randolph Center	8/20	Distribution system	Finished	Ground	0	0		
	8/20	Well	Raw	Ground	0	0		
Readsboro	8/5	Distribution system	Raw	Surface	0	4		
Richford	7/8	Distribution system	Finished	Surface	0	4		
Richmond	7/24	Treatment plant	Raw	Ground	0	0		
Rochester	7/22	Distribution system	Raw	Ground	0	0		
Rutland	7/10–7/23	Treatment plant	Finished	Surface	0	0		
	8/27	Distribution system	Finished	Ground	0	0		
St. Albans	7/17–7/31	Treatment plant	Finished	Surface	0	4		
	7/17–7/31	Treatment plant	Finished	Surface	0	6		
St. George	8/28	Well	Other	Ground	10	5	0.4	
St. Johnsbury	7/10	Treatment plant	Finished	Surface	0	4		
St. Johnsbury Center	8/6	Distribution system	Finished	Ground	0	4		
Saxtons River	7/29	Distribution system	Raw	Ground	0	0		
	7/29	Distribution system	Raw	Ground	0	6		
Sharon	8/25	Well	Finished	Ground	0	0		
Shelburne	7/18	Distribution system	Finished	Combined	0	3		
	8/27	Other	Raw	Surface	0	5		
Sheldon	7/24	Distribution system	Finished	Ground	3	4		
Sheldon Springs	8/21	Other	Raw	Surface	0	6		
	8/21	Well	Raw	Ground	0	3		
	8/21	Treatment plant	Finished	Surface	0	4		
South Barre	8/19	Distribution system	Finished	Ground	6	7	.5	
South Burlington	8/20	Distribution system	Finished	Ground	0	0		
South Hero	7/8	Other	Finished	Surface	0	6		
	7/8	Other	Finished	Surface	0	6		
	7/8	Other	Finished	Surface	0	5		
South Royalton	8/25	Reservoir	Raw	Combined	0	5		
	8/25	Reservoir	Raw	Ground	0	0		
	8/25	Well	Finished	Ground	0	6		
	7/22	Distribution system	Raw	Combined	0	7		
South Ryegate	8/5	Other	Raw	Ground	0	0		
South Troy	7/15	Reservoir	Finished	Surface	0	0		
South Wallingford	8/4	Distribution system	Finished	Ground	0	0		
Springfield	7/16	Well	Raw	Ground	0	0		
	7/13	Well	Finished	Ground	0	6		
	7/14	Treatment plant	Partially treated	Surface	0	0		
Starksboro	8/18	Other	Finished	Ground	0	0		
Stowe	7/25	Distribution system	Finished	Other	0	0		
	7/25	Distribution system	Finished	Combined	0	0		
Stratton Mountain	8/4	Other	Raw	Surface	0	4		
Sutton	8/6	Other	Raw	Ground	0	0		
Swanton	7/8	Reservoir	Raw	Surface	0	8		
Thetford	8/21	Other	Finished	Ground	0	4		
Tri-Town Water District	7/18–8/1	Treatment plant	Finished	Surface	0	6		
Vergennes	7/8	Distribution system	Finished	Surface	0	0		
Wallingford	7/9	Distribution system	Finished	Combined	0	0		
Warren	8/29	Distribution system	Finished	Ground	0	0		
Washington	8/27	Distribution system	Finished	Ground	0	9		
Waterbury	8/28	Distribution system	Finished	Ground	7	6	1.8	
	7/10	Well	Raw	Ground	0	7		
	7/10–7/23	Treatment plant	Partially treated	Surface	0	0		
Waterbury Center	8/18	Distribution system	Finished	Ground	0	0		
	8/18	Distribution system	Finished	Ground	0	3		
Waterville	8/27	Other	Raw	Ground	0	0		
Websterville	8/19	Reservoir	Raw	Surface	0	3		
	8/26	Distribution system	Raw	Ground	0	3		
Wells River	8/25	Well	Raw	Ground	0	5		
West Burke	8/5	Other	Raw	Surface	0	0		
	8/5	Other	Raw	Ground	0	0		
Westfield	7/28	Distribution system	Raw	Other	0	3		
Westminster	7/29	Distribution system	Raw	Ground	0	0		
West Rutland	8/27	Distribution system	Finished	Ground	0	0		
	7/17	Distribution system	Raw	Ground	0	0		
Wheelock	8/6	Distribution system	Raw	Ground	0	3		
White River Junction	7/14	Treatment plant	Finished	Combined	0	0		
Williamstown	8/25	Well	Partially treated	Ground	0	0		
	8/28	Reservoir	Raw	Ground	0	3		
Williston	8/29	Well	Other	Ground	3	3		
	8/27	Distribution system	Finished	Ground	17	10	1.7	
	8/28	Distribution system	Other	Ground	11	7	2.7	
	9/3	Reservoir	Partially treated	Ground	0	7		
	9/3	Reservoir	Partially treated	Ground	0	0		
	8/28	Well	Raw	Ground	9	3	6	
	8/28	Well	Raw	Ground	10	4	1.0	

See footnotes at end of table.

Table 7. Radioactivity in community water supplies, 1969, State of Vermont—continued

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
Vermont—continued								
Wilmington	7/17	Distribution system	Finished	Ground	0	0		
Windsor	8/7	Well	Raw	Ground	0	0		
Winooski	8/4	Distribution system	Finished	Ground	3	5		
Woodstock	7/12–7/26	Distribution system	Finished	Surface	0	0		
Worcester	8/19	Well	Finished	Ground	0	0		

[a] The locations shown are the mailing addresses for the community from which the water supply was sampled.

[b] The minimum detectable radioactivity is 2 pCi/liter for gross alpha, gross beta, and strontium-90; and 0.1 pCi/liter for radium-226. All values equal to or less than the minimum detectable concentration have been reported as zero.

four counties around New York City and the city itself. The four counties were: Rockland, Westchester, Nassau, and Suffolk. New York City is actually composed of five counties: Bronx, Queens, Kings (Brooklyn), Richmond (Staten Island), and New York (Manhattan). A total of 221 water supplies serving 12,356,300 people was studied. The New York, New York SMSA was selected to represent those water supplies utilizing surface water, providing disinfection only for treatment, and those utilizing ground waters from high population-density areas. It also represents the highly urbanized (megapolis) areas of the United States.

The Charleston, West Virginia SMSA included all of Kanawha County. The study included 30 public water supplies serving about 229,300 people, or about 91 percent of the SMSA population. This area was selected to represent those supplies using surface waters that receive the wastes from a highly industrialized area. The small coal mine town water samples represent supplies in economically depressed areas of the northern Appalachian region.

The Charleston, South Carolina SMSA consisted of Berkeley and Charleston Counties, and included 22 water supplies serving about 251,100 of the 296,000 people in the SMSA. This area represents the Atlantic and Gulf coast areas using both surface and ground water.

The Cincinnati, Ohio-Kentucky-Indiana SMSA included Clermont, Hamilton, and Warren Counties in Ohio, Boone, Campbell, and Kenton Counties in Kentucky, and Dearborn County in Indiana. The study covered 66 water supplies serving 1,366,000 of the 1,409,000 people in the SMSA. This area was selected to represent those portions of mid-America using surface water receiving a considerable amount of industrial discharge in addition to municipal wastes and agriculture runoff.

The Kansas City, Missouri-Kansas SMSA included Cass, Clay, Jackson, and Platte Counties in Missouri and Johnson and Wyandotte Counties in Kansas. A total of 88 water supplies serving 1,383,500 people was surveyed. This SMSA was selected to represent surface waters with a large agriculture runoff to industrial waste ratio.

The New Orleans, Louisiana SMSA consisted of Jefferson, Orleans, St. Bernard, and St. Tammany Parishes and included 26 water supplies serving 1,085,400 people. The SMSA was selected to represent the supplies receiving surface water drained from large and varied river basins, plus some deep artesian wells.

The Pueblo, Colorado SMSA included Pueblo County and 20 water supply systems serving 111,500 people were surveyed. This area has water supplies of the high plains region of the country and also has a mixture of ground water and surface water sources.

The San Bernardino-Riverside-Ontario, California SMSA included Riverside and San Bernardino Counties. A total of 278 water supply systems serving 1,113,400 people was surveyed in this study. This area represents the semiarid regions of the west and southwest as well as an area served primarily by ground water.

A summary of the national findings in this study and the reports on each SMSA studied and the State of Vermont, may be found in references *3* through *12*.

Table 2. Radioactivity in community water supplies, 1969, New York, New York SMSA

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
Connecticut:								
Greenwich [c]	6/4–6/19	Treatment plant	Finished	Surface	0	4		
New York:								
Amagansett	8/27	Well	Raw	Ground	0	0		
Amityville	8/5	Treatment plant	Finished	Ground	0	3		
	8/5	Treatment plant	Finished	Ground	0	0		
Armonk	5/28	Well	Finished	Ground	0	3		
Babylon	8/5	Treatment plant	Finished	Ground	0	0		
	8/5	Treatment plant	Finished	Ground	0	0		
	8/5	Treatment plant	Finished	Ground	0	0		
	8/5	Treatment plant	Finished	Ground	0	0		
Bayshore	8/6	Treatment plant	Finished	Ground	0	0		
	8/6	Treatment plant	Finished	Ground	0	0		
	8/5	Treatment plant	Finished	Ground	0	4		
Bayville	7/16	Well	Raw	Ground	0	0		
	7/16	Well	Raw	Ground	0	0		
Bedford	5/21	Well	Raw	Ground	0	5		
Bedford Hills	5/28	Distribution system	Finished	Ground	0	4		
	5/26	Distribution system	Finished	Ground	0	0		
Bethpage	7/14–7/28	Treatment plant	Finished	Ground	0	4		
Blauvelt	5/2	Well	Finished	Ground	0	0		
Blue Point	8/18	Well	Raw	Ground	0	0		
Brentwood	8/4	Well	Raw	Ground	0	0		
	8/4	Well	Raw	Ground	0	0		
Braircliff	5/19	Other	Finished	Ground	0	4		
Bridgehampton	8/27	Well	Raw	Ground	0	4		
Bronxville	5/26	Other	Finished	Ground	0	5		
Calverton	8/22	Well	Finished	Ground	0	5		
	8/21	Well	Raw	Ground	0	5		
Camp Addisone Boyce (Tomkins Cove)	7/10	Well	Raw	Ground	0	6		
Camp Bullowa (Stoney Point)	7/9	Well	Raw	Ground	0	3		
	7/9	Well	Raw	Ground	0	0		
Camp Jawonia (New City)	5/8	Distribution system	Finished	Ground	0	0		
Camp Low Acres (Spring Valley)	7/10	Well	Raw	Ground	0	0		
Camp Ramaquois (Pomona)	7/10	Well	Raw	Ground	0	0		
Camp Smith (Peekskill)	7/9	Treatment plant	Finished	Ground	0	0		
Camp Williams (Suffern)	7/10	Well	Raw	Ground	0	0		
Carle Place	7/15	Well	Raw	Ground	0	4		
	7/15	Well	Raw	Ground	0	0		
Central Islip	8/18	Treatment plant	Finished	Ground	0	0		
Chappaqua	5/23–6/6	Treatment plant	Finished	Surface	0	4		
Cherry Grove	8/26	Well	Other	Ground	0	0		
Coram	8/5	Well	Raw	Ground	0	0		
Cove Neck	8/1	Well	Raw	Ground	0	0		
Croton	5/27	Well	Finished	Ground	0	3		
Davis Park	8/27	Well	Other	Ground	0	0		
Dunewood	8/25	Treatment plant	Finished	Ground	0	3		
East Hampton	8/7	Treatment plant	Finished	Ground	0	0		
East Meadow	7/14	Treatment plant	Finished	Ground	0	3		
East Patchogue	8/20	Well	Raw	Ground	0	0		
East Quogue	8/21	Well	Raw	Ground	0	0		
Fair Harbor	8/21	Well	Other	Ground	0	4		
Farmingdale	8/4	Distribution system	Finished	Ground	0	0		
	7/18	Well	Finished	Ground	0	0		
	8/4	Distribution system	Finished	Ground	0	3		
Fair Island Pines	8/27	Well	Raw	Ground	0	0		
Fishers Island	8/29	Treatment plant	Finished	Surface	0	6		
Franklin Square	7/28	Distribution system	Finished	Ground	0	0		
Freeport	7/14	Treatment plant	Finished	Ground	0	0		
Garden City Park	7/29	Well	Raw	Ground	0	0		
	7/29	Well	Raw	Ground	0	0		
Garden City	7/14	Well	Raw	Ground	0	3		
	7/14	Well	Raw	Ground	0	0		
	7/14	Well	Raw	Ground	0	0		
Garnerville	5/2	Distribution system	Finished	Ground	0	0		
	5/5	Well	Finished	Ground	0	0		
	5/8	Well	Raw	Ground	0	0		
Glen Cove	7/17	Well	Finished	Ground	0	0		
	7/17	Reservoir	Finished	Ground	0	0		
Goldens Bridge	5/28	Well	Finished	Ground	0	3		
	7/8	Well	Raw	Ground	3	6		
	7/8	Well	Raw	Ground	0	3		
Great Neck	7/16	Well	Finished	Ground	0	0		
Greenlawn	8/19	Well	Raw	Ground	0	0		
Greenport	8/25	Well	Raw	Ground	0	4		
Hampton Bays	8/21	Distribution system	Finished	Ground	0	0		
Harrison	7/8	Well	Raw	Ground	0	3		
Haverstraw	5/15	Distribution system	Other	Ground	0	3		
Hempstead	7/29	Treatment plant	Finished	Ground	0	0		
Hicksville	7/15	Distribution system	Finished	Ground	3	5		
Hillburn	5/5	Distribution system	Finished	Surface	0	0		

See footnotes at end of table.

Table 2. Radioactivity in community water supplies, 1969, New York, New York SMSA—continued

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
New York—continued								
Huntington	8/6	Treatment plant	Finished	Ground	0	0		
	8/6	Treatment plant	Finished	Ground	0	0		
	8/19	Well	Raw	Ground	0	0		
	8/19	Well	Finished	Ground	0	0		
	8/18	Distribution system	Raw	Ground	0	0		
Huntington Station	8/19	Distribution system	Finished	Ground	0	0		
Irvington	5/20–6/2	Other	Finished	Surface	0	5		
Jamaica	9/11	Well	Finished	Ground	3	0		
	9/11	Well	Finished	Ground	0	0		
	9/10	Treatment plant	Partially treated	Ground	0	0		
	9/10	Treatment plant	Partially treated	Ground	0	3		
Jericho	7/14	Well	Raw	Ground	0	0		
	7/14	Well	Raw	Ground	0	3		
	7/14	Well	Raw	Ground	0	0		
Katonah	5/21	Well	Finished	Ground	0	6		
	7/8	Well	Raw	Ground	6	11		
Kings Park	8/20	Distribution system	Finished	Ground	0	0		
Kismet	8/21	Well	Other	Ground	0	0		
Lake Grove	9/9	Distribution system	Other	Ground	0	0		
	9/9	Distribution system	Other	Ground	0	3		
	8/5	Well	Finished	Ground	0	0		
Lake Ronkonkoma	8/6	Well	Raw	Ground	0	0		
Larchmont	5/22–6/5	Treatment plant	Finished	Surface	0	9		
Levittown	7/15	Treatment plant	Finished	Ground	0	0		
Locust Valley	7/17	Well	Raw	Ground	0	0		
Long Beach	7/17	Well	Raw	Ground	0	0		
Lynbrook	7/29	Treatment plant	Finished	Ground	0	3		
	7/29–8/12	Treatment plant	Finished	Ground	0	0		
Mamaroneck	5/29–6/13	Treatment plant	Finished	Surface	0	11		
Manhasset	7/16	Distribution system	Finished	Ground	0	0		
Massapequa	7/29	Distribution system	Finished	Ground	0	0		
	7/29	Distribution system	Finished	Ground	0	0		
Mattituck	8/20	Distribution system	Finished	Ground	0	0		
Melville	8/19	Distribution system	Finished	Ground	0	0		
Merrick	8/1	Other	Finished	Ground	0	0		
	8/1	Distribution system	Finished	Ground	0	0		
	7/30	Reservoir	Finished	Ground	0	0		
	7/30	Reservoir	Finished	Ground	0	0		
	7/30	Well	Raw	Ground	0	10		
	7/30	Well	Raw	Ground	0	0		
Miller Place	8/5	Well	Raw	Ground	0	0		
	8/6	Well	Finished	Ground	0	0		
Mill Neck	7/17	Well	Raw	Ground	0	0		
Mineola Village	7/31	Well	Raw	Ground	0	0		
	7/31	Well	Raw	Ground	0	0		
Mineola	7/30	Well	Raw	Ground	0	0		
	7/30	Well	Raw	Ground	0	0		
Montauk	8/28	Well	Raw	Ground	0	0		
	8/28	Distribution system	Finished	Ground	0	0		
Mt. Ivy	5/7	Well	Raw	Ground	0	0		
	5/8	Distribution system	Finished	Ground	0	0		
	5/9	Distribution system	Finished	Ground	3	0		
	5/9	Well	Finished	Ground	0	0		
	5/7	Distribution system	Finished	Ground	0	0		
Mt. Kisco	5/23	Treatment plant	Finished	Surface	0	5		
Mt. Sinai	8/5	Well	Raw	Ground	0	0		
Mountain Lakes Camp (North Salem)	9/26	Well	Raw	Ground	0	0		
Nanuet	5/5	Well	Other	Ground	0	0		
New City	5/2	Distribution system	Finished	Ground	0	0		
New Rochelle	5/28	Treatment plant	Finished	Surface	0	5		
New York City (Ashokan Reservoir)	6/23–7/7	Reservoir	Partially treated	Surface	0	0		
New York City (Pleasantville)	6/26–7/9	Reservoir	Partially treated	Surface	0	0		
New York City (Croton Watershed)	7/15–7/29	Reservoir	Finished	Surface	0	4		
	7/16–7/30	Reservoir	Finished	Surface	0	6		
New York City (Croton Lake)	7/15–7/28	Reservoir	Partially treated	Surface	0	0		
New York City (Grahamsville)	6/23–7/7	Reservoir	Partially treated	Surface	0	0		
New York City (North Castle)	6/26–7/9	Reservoir	Partially treated	Surface	0	3		
New York City (East View)	6/26–7/9	Reservoir	Finished	Surface	0	0		
New York City (Woodhaven)	9/11	Distribution system	Finished	Ground	0	14		0
	9/11	Well	Finished	Ground	0	5		
	9/11	Well	Finished	Ground	0	0		
Northport	8/6	Treatment plant	Finished	Ground	0	0		
	8/6	Treatment plant	Finished	Ground	0	0		
North Salem	5/27	Distribution system	Finished	Ground	0	3		
	7/9	Well	Raw	Ground	0	4		
	5/28	Distribution system	Finished	Ground	0	6		
North White Plains	5/26	Treatment plant	Finished	Ground	0	3		
Nyack	5/6–5/19	Treatment plant	Finished	Surface	0	5		
Ocean Bay Park	8/26	Treatment plant	Finished	Ground	0	0		
Ocean Beach	8/27	Well	Other	Ground	0	4		
	8/28	Well	Other	Ground	0	4		

See footnotes at end of table.

Table 2. Radioactivity in community water supplies, 1969, New York, New York SMSA—continued

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
New York—continued								
Old Westbury	7/30	Well	Raw	Ground	0	0		
	7/30	Well	Raw	Ground	0	0		
Orangeburg	5/9	Reservoir	Other	Ground	0	3		
	5/7	Well	Other	Ground	0	0		
Oyster Bay	7/18	Well	Raw	Ground	0	0		
	7/18	Treatment plant	Finished	Ground	0	0		
Patchogue	8/6	Treatment plant	Finished	Ground	0	0		
	8/6	Treatment plant	Finished	Ground	0	0		
Peconic	8/21	Distribution system	Raw	Ground	0	0		
Peekskill	5/23–6/5	Treatment plant	Finished	Surface	0	0		
Plainview	7/30	Distribution system	Finished	Ground	0	0		
	7/30	Distribution system	Finished	Ground	0	0		
Plandome	7/16	Well	Other	Ground	0	0		
Pocantico Hills	5/20–6/2	Treatment plant	Finished	Surface	0	5		
	5/28	Distribution system	Raw	Ground	0	7		
Point Lookout	7/16	Treatment plant	Finished	Ground	0	0		
Point O'Woods	8/26	Well	Other	Ground	0	0		
Pomona	5/6	Reservoir	Finished	Ground	0	0		
Port Jefferson	8/7	Distribution system	Finished	Ground	0	0		
	8/6	Treatment plant	Finished	Ground	0	0		
	8/6	Treatment plant	Finished	Ground	0	0		
	9/8	Distribution system	Finished	Ground	0	23		0
Port Washington	7/16	Reservoir	Finished	Ground	0	0		
Riverhead	8/21	Well	Finished	Ground	0	3		
	8/20	Well	Raw	Ground	0	0		
Rockville Center	7/17	Well	Raw	Ground	0	0		
	7/17	Well	Raw	Ground	0	0		
Rocky Point	9/10	Distribution system	Finished	Ground	0	0		
	8/5	Well	Raw	Ground	0	0		
	8/8	Well	Raw	Ground	0	0		
	8/5	Well	Raw	Ground	0	0		
Ronkonkoma	9/10	Distribution system	Other	Ground	0	0		
Roslyn	7/18	Well	Raw	Ground	0	0		
	7/18	Well	Raw	Ground	0	0		
Roslyn Heights	8/1	Distribution system	Other	Ground	0	3		
	8/5	Well	Finished	Ground	0	0		
Sagamore Hill historic site	8/1	Well	Raw	Ground	0	0		
	8/1	Well	Partially treated	Ground	0	0		
Sag Harbor	8/7	Treatment plant	Finished	Ground	0	0		
Saltaire	8/21	Well	Other	Ground	0	4		
Sands Point	7/16	Other	Finished	Ground	0	0		
Scarsdale	5/22	Treatment plant	Finished	Surface	0	5		
Sea Cliff	7/15	Well	Raw	Ground	0	3		
	7/15	Well	Raw	Ground	0	0		
Seaview	8/25	Treatment plant	Finished	Ground	0	4		
Seldon	8/20	Well	Raw	Ground	0	0		
Shelter Island	8/26	Distribution system	Finished	Ground	0	7		
	8/26	Well	Raw	Ground	0	0		
Shenrock	5/26	Treatment plant	Finished	Combined	0	3		
Shirley	9/8	Distribution system	Finished	Ground	0	0		
Shrub Oak	6/3–6/17	Other	Other	Ground	0	3		
Sloatsburg	4/30	Distribution system	Finished	Surface	0	4		
	5/7	Distribution system	Finished	Surface	0	0		
Smithtown	8/6	Treatment plant	Finished	Ground	0	0		
	8/6	Treatment plant	Finished	Ground	0	0		
Southampton	8/7	Treatment plant	Finished	Ground	0	0		
	8/21	Well	Finished	Ground	0	0		
South Farmingdale	7/16	Well	Raw	Ground	0	3		
	7/16	Well	Raw	Ground	0	0		
South Salem	7/9	Reservoir	Raw	Ground	8	8		
Sparkill	5/6	Distribution system	Finished	Ground	0	0		
Spring Valley	5/15	Well	Other	Ground	0	0		
	5/2	Distribution system	Finished	Combined	0	0		
	5/2–5/15	Treatment plant	Finished	Surface	0	4		
Stony Brook	8/6	Well	Raw	Ground	0	0		
Stony Point	5/8	Distribution system	Finished	Ground	0	0		
Suffern	5/5	Distribution system	Finished	Ground	0	4		
	5/6	Distribution system	Finished	Ground	0	0		
Tarrytown	5/21–6/3	Treatment plant	Finished	Surface	0	6		
Thiells	5/8–5/21	Treatment plant	Finished	Surface	0	3		
Thornwood	5/21	Treatment plant	Raw	Ground	0	0		
Truesdale	7/9	Reservoir	Raw	Ground	0	4		
Uniondale	7/15	Treatment plant	Finished	Ground	0	0		
Valley Cottage	5/8	Distribution system	Finished	Ground	4	3	0	
	7/10	Distribution system	Raw	Ground	0	0		
	5/9	Distribution system	Finished	Ground	0	0		
	5/7	Well	Finished	Ground	3	0		
Wading River	8/7	Well	Raw	Ground	0	0		
	8/6	Well	Raw	Ground	0	0		
	8/7	Well	Raw	Ground	0	0		
	8/7	Well	Raw	Ground	0	3		
West Brentwood	8/19	Treatment plant	Finished	Ground	0	0		
Westbury	7/14	Treatment plant	Finished	Ground	3	3		
	7/28	Reservoir	Raw	Ground	0	0		
	7/28	Well	Raw	Ground	0	0		
West Gilgo Beach	8/22	Treatment plant	Finished	Ground	0	7		
Westhampton	8/7	Treatment plant	Finished	Ground	0	0		

See footnotes at end of table.

Table 2. Radioactivity in community water supplies, 1969, New York, New York SMSA—continued

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross btta	^{226}Ra	^{90}Sr
New York—continued								
West Haverstraw	5/1	Well	Finished	Ground	0	0		
West Hempstead	7/31	Reservoir	Finished	Ground	0	3		
West Island	8/28	Other	Other	Ground	0	4		
White Plains	5/27	Other	Finished	Surface	0	3		
Williston Park	8/1	Well	Raw	Ground	0	0		
	8/1	Well	Raw	Ground	0	0		
Yonkers	7/9–7/22	Other	Finished	Surface	0	0		

[a] The locations shown are the mailing addresses for the community from which the water supply was sampled.
[b] The minimum detectable radioactivity is 2 pCi/liter for gross alpha, gross beta, and strontium-90; and 0.1 pCi/liter for radium-226. All values equal to or less than the minimum detectable concentration have been reported as zero.
[c] Treatment plant that services a portion of the New York, New York SMSA.

Table 3. Radioactivity in community water supplies, 1969, Charleston, West Virginia SMSA

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross btta	^{226}Ra	^{90}Sr
West Virginia:								
Belle	3/20–4/2	Treatment plant	Finished	Surface	0	0		
Burnwell	3/26	Treatment plant	Finished	Ground	0	0		
Carbon	3/24	Distribution system	Finished	Ground	0	0		
Cedar Grove	3/20–4/3	Treatment plant	Finished	Surface	0	0		
Charleston	3/19–4/1	Treatment plant	Finished	Surface	0	0		
Chelyan	3/20–4/3	Treatment plant	Finished	Surface	0	0		
Clendenin	3/18–4/1	Treatment plant	Finished	Surface	0	0		
Corton	3/18	Treatment plant	Finished	Surface	0	0		
Decota	3/26–4/8	Treatment plant	Finished	Ground	0	3		
Handley	3/26–4/8	Treatment plant	Finished	Surface	0	0		
Kayford	3/25	Distribution system	Finished	Surface	0	5		0
Leewood	3/25	Distribution system	Finished	Ground	0	0		
	3/25	Well	Finished	Ground	0	3		
Miami	3/20–4/3	Treatment plant	Finished	Ground	0	3		
Montgomery	3/25–4/6	Treatment plant	Finished	Surface	0	0	0	
Mount Tyler	3/21–4/11	Treatment plant	Finished	Ground	0	3		
Nitro	3/21–4/3	Treatment plant	Finished	Surface	0	4		
Pinch	3/18–3/31	Treatment plant	Finished	Surface	0	0	0	
Pratt	3/24–4/13	Treatment plant	Finished	Surface	0	0		
Rensford	3/17	Distribution system	Raw	Ground	0	6		
Republic	3/24	Distribution system	Finished	Ground	0	0		
Sharon	3/20–4/3	Treatment plant	Finished	Ground	0	7		0
Shrewsbury	3/20–4/3	Treatment plant	Finished	Ground	0	0		
Sissonville	3/17–3/31	Treatment plant	Finished	Surface	0	3		
St. Albans	3/17–3/31	Treatment plant	Finished	Surface	0	0		
Ward	3/26	Well	Raw	Ground	0	3		
Winifrede	3/18	Distribution system	Raw	Ground	0	5		0

[a] The locations shown are the mailing addresses for the community from which the water supply was sampled.
[b] The minimum detectable radioactivity is 2 pCi/liter for gross alpha, gross beta, and strontium-90; and 0.1 pCi/liter for radium-226. All values equal to or less than the minimum detectable concentration have been reported as zero.

Results and discussion

At least one water sample from each water system in this study was sent to either the Northeastern Radiological Health Laboratory, Western Environmental Research Laboratory (now the National Environmental Research Center—Las Vegas), or the Eastern Environmental Radiation Laboratory for analysis. The samples were collected by the grab sampling method on the date shown except where a range of dates indicates a composite of samples collected over that period of time.

The Drinking Water Standards (*2*) set limits for radioactivity at 3 pCi/liter for radium-226, 10 pCi/liter for strontium-90, and 1,000 pCi/liter for gross beta in the known absence of strontium-90 and alpha emitters. In this study, gross alpha and beta radioactivity analyses were performed on all samples. A radium-226 analysis was performed if the gross alpha radioactivity exceeded 3 pCi/liter, and a strontium-90 analysis was performed if the gross beta radioactivity exceeded 10 pCi/liter.

Tables 1 through 9 show the results of the individual measurements made in each SMSA and Vermont, and table 10 is a summary of the data in this study. The locations shown in tables 1–9 are the mailing addresses for the community from which the water supply was sampled. Gamma scans were performed on all samples, but since no detectable activity was found in any sample, these results have been omitted from tables 1–10. Tritium analyses were performed on 144 selected samples from this study and these results have previously been published (*13*).

As indicated in table 10, no sample exceeded 10 pCi/liter for strontium-90, but 7 samples exceeded 3 pCi/liter for radium-226. The maximum radium-226 concentration for an individual sample was 136 pCi/liter for Rye, Colo. This sample was from a well that provides up to 50 percent of the total water supply to 600 residents during the summer months to supplement the surface water supply.

The second highest radium-226 concentration was 76.5 pCi/liter in the Pueblo, Colorado. SMSA. This was taken from the community of Kirkland, Colo. with a population of 50. Assuming that the concentration of radium-226 in all water taken into the body is equal to that found in the drinking water, and assuming an intake of 2.2 liters/day (*14*) for 50 years at that concentration, then the yearly radiation dose to a suitable sample of the exposed population may be estimated. By using the guidelines of NCRP Report No. 39 (*15*) and FRC Report No. 2 (*16*), the mean skeletal dose rate from a permissible burden of 0.1 μCi radium-226 plus 30 percent daughters is 30 rem/a. The Radiation Protection Guide (RPG) for suitable samples of the exposed population is a skeletal concentration of radium-226 corresponding to 0.001 μCi in the adult skeleton. A continuous daily intake of 20 pCi/day of radium-226 for 50 years would correspond to the RPG of 0.001 μCi radium-226 in the adult skeleton, and this would result in a dose of 0.3 rem/a after 50 years. In the case of people consuming drinking water containing 76.5 pCi/liter of radium-226 for 50 years, then

Table 4. Radioactivity in community water supplies, 1969, Charleston, South Carolina SMSA

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
South Carolina:								
Charleston	3/3	Well	Raw	Ground	0	0		
	3/6	Distribution system	Finished	Surface	0	13		0
	3/4–3/18	Treatment plant	Finished	Surface	0	0		
Charleston Heights	3/6	Distribution system	Raw	Ground	0	0	0	
Edisto Beach	3/4	Distribution system	Other	Ground	0	27		
	3/4	Distribution system	Other	Ground	0	14		0
	3/4	Well	Other	Ground	0	28		0
Goose Creek	3/6	Well	Raw	Ground	0	11		0
	3/6	Distribution system	Finished	Ground	0	11		0
	3/6	Distribution system	Finished	Ground	0	12		0
	3/5	Distribution system	Finished	Ground	0	11		
Isle of Palms	3/4	Distribution system	Finished	Ground	0	5		
Johns Island	3/5	Well	Other	Ground	0	3	0	
Moncks Corner	3/6	Well	Raw	Ground	0	15		0
Mount Pleasant	3/4	Reservoir	Finished	Ground	0	14		
	3/5	Treatment plant	Finished	Ground	0	40		
	3/5	Distribution system	Finished	Ground	0	0		
Pinopolis	3/7	Distribution system	Raw	Ground	0	5		
St. Stephen	3/3	Well	Raw	Ground	0	5		
Sullivans Island	3/3	Distribution system	Finished	Ground	0	0		

[a] The locations shown are the mailing addresses for the community from which the water supply was sampled.
[b] The minimum detectable radioactivity is 2 pCi/liter for gross alpha, gross beta, and strontium-90; and 0.1 pCi/liter for radium-226. All values equal to or less than the minimum detectable concentration have been reported as zero.

Table 5. Radioactivity in community water supplies, 1969, Cincinnati, Ohio-Kentucky-Indiana SMSA

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
Indiana:								
Aurora	3/6-3/20	Treatment plant	Finished	Ground	0	0		
Dillsboro	3/7-3/20	Distribution system	Finished	Other	0	0		
Lawrenceburg	3/5-3/13	Treatment plant	Finished	Ground	0	0		
	3/6-3/20	Treatment plant	Finished	Ground	0	0		
	3/6-3/19	Distribution system	Finished	Ground	0	0		
Kentucky:								
Burlington	3/3-3/18	Distribution system	Finished	Surface	0	0		
Covington	3/5-3/19	Treatment plant	Finished	Surface	0	0		
Ft. Thomas	3/5-3/18	Other	Finished	Surface	0	0		
Newport	3/4-3/17	Treatment plant	Finished	Surface	0	0		
Silver Grove	3/4	Treatment plant	Finished	Ground	0	0		
Walton	3/4-3/18	Treatment plant	Finished	Surface	0	0		
Winston Park	3/6-3/19	Treatment plant	Finished	Surface	0	0		
Ohio:								
Addyston	2/28	Distribution system	Finished	Ground	0	0		
Amelia	2/27-3/13	Distribution system	Finished	Ground	0	0		
Batavia	3/4-3/17	Treatment plant	Finished	Surface	0	3		
Bethel	3/3-3/17	Treatment plant	Finished	Surface	0	3		
Branch Hill	3/4-3/18	Distribution system	Finished	Ground	0	0		
Cincinnati	3/3-3/16	Treatment plant	Finished	Surface	0	0		
Cleves	2/27-3/12	Treatment plant	Finished	Ground	0	0		
Felicity	2/28-3/14	Well	Raw	Ground	0	0		
Franklin	3/3-3/16	Distribution system	Finished	Ground	0	0		
Glendale	3/3-3/16	Treatment plant	Finished	Ground	0	0		
Harrison	2/27-3/12	Treatment plant	Finished	Ground	0	0		
Indian Hill	2/27-3/12	Treatment plant	Finished	Ground	0	0		
Lebanon	2/27-3/12	Treatment plant	Finished	Ground	0	0		
	2/28-3/17	Treatment plant	Finished	Ground	0	0		
	3/4	Distribution system	Raw	Ground	0	0		
Lockland	2/28-3/13	Treatment plant	Finished	Ground	0	0		
Loveland	3/4	Distribution system	Finished	Ground	0	0		
Mason	3/4-3/17	Treatment plant	Partially treated	Ground	0	0		
	3/6-3/20	Distribution system	Finished	Combined	0	0		
Milford	3/3-3/17	Treatment plant	Finished	Ground	0	0		
	2/28-3/14	Treatment plant	Finished	Ground	0	0		
	2/27-3/13	Treatment plant	Finished	Ground	0	0		
Morrow	3/3-3/18	Distribution system	Finished	Ground	0	0		
New Richmond	3/4-3/8	Treatment plant	Finished	Ground	0	0		
Norwood	2/27-3/13	Distribution system	Finished	Ground	0	0		
Reading	2/28-3/14	Treatment plant	Finished	Ground	0	0		
South Lebanon	3/3	Distribution system	Raw	Ground	3	7		
Springboro	3/4-3/17	Treatment plant	Finished	Ground	0	6		
	3/4-3/17	Treatment plant	Finished	Ground	0	0		
Waynesville	3/3-3/17	Well	Finished	Ground	0	0		
Williamsburg	2/28-3/14	Treatment plant	Finished	Surface	0	0		
Wyoming	2/27-3/12	Treatment plant	Finished	Ground	0	0		

[a] The locations shown are the mailing addresses for the community from which the water supply was sampled.

[b] The minimum detectable radioactivity is 2 pCi/liter for gross alpha, gross beta, and strontium-90; and 0.1 pCi/liter for radium-226. All values equal to or less than the minimum detectable concentration have been reported as zero.

the average yearly dose after 50 years would be about 2.5 rem/a from the body burden of 0.0084 μCi of radium-226 in the adult skeleton.

The two intakes of radium-226 in Rye and Kirkland, Colo. fall within the Federal Radiation Council's (*16*) Range III scale of actions. Surveillance should be adequate to define clearly the extent of the exposure and control actions should be designed to reduce the levels to Range II or lower and to provide stability at lower levels.

The State of Colorado has closed the original two wells in Kirkland since the survey. An additional well has been dug and treatment is being provided to reduce the levels of radium-226. Since water from the well in Rye is used only when the surface water supply is low, no treatment has been initiated.

REFERENCES

(*1*) EXECUTIVE OFFICE OF THE PRESIDENT/BUREAU OF THE BUDGET. Standard metropolitan statistical areas (1967).

(*2*) U.S. PUBLIC HEALTH SERVICE. Drinking water standards, revised 1962, PHS Publication No. 956. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (March 1963).

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Table 6. Radioactivity in community water supplies, 1969, Kansas City, Kansas-Missouri SMSA

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
Kansas:								
Bethel	6/12	Treatment plant	Finished	Ground	0	6		
Bonner Springs	6/12	Treatment plant	Finished	Ground	0	9		
De Soto	6/13	Treatment plant	Finished	Ground	0	4		
	6/2–6/16	Treatment plant	Finished	Surface	0	10		
Edgerton	6/4–6/17	Treatment plant	Finished	Surface	0	11		0
Gardner	6/4–6/18	Treatment plant	Finished	Surface	0	7		
Kansas City	6/11	Well	Raw	Ground	0	0		
	6/3–6/17	Treatment plant	Finished	Surface	0	6		
Olathe	6/11–6/24	Treatment plant	Finished	Ground	3	5		
	6/4–6/18	Treatment plant	Finished	Surface	0	7		
	6/17	Treatment plant	Finished	Surface	0	7		
	6/11	Distribution system	Finished	Ground	0	23		0
Shawnee-Mission	6/2–6/16	Treatment plant	Finished	Combined	0	0		
Spring Hill	6/4–6/17	Treatment plant	Finished	Surface	0	5		
Stillwell	6/4–6/18	Treatment plant	Finished	Surface	0	0		
Missouri:								
Archie	6/6–6/19	Treatment plant	Finished	Surface	0	6		
Belton	6/11	Distribution system	Finished	Other	0	10		
	6/11	Distribution system	Finished	Surface	0	5		
	6/11	Well	Raw	Ground	0	4		
Camden Point	6/16	Treatment plant	Finished	Ground	0	0		
Cleveland	6/5–6/18	Treatment plant	Finished	Surface	0	9		
Creighton	6/10	Well	Raw	Ground	6	12	4.3	0
Dearborn	6/18–7/1	Treatment plant	Finished	Surface	0	0		
Drexel	6/6–6/19	Treatment plant	Finished	Surface	0	11		0
East Lynne	6/9	Well	Finished	Ground	0	0		
Edgerton	6/18	Treatment plant	Finished	Ground	0	0		
Excelsior Springs	6/19	Treatment plant	Finished	Ground	0	0		
Farley	6/18	Treatment plant	Finished	Ground	0	0		
Freeman	6/5–6/18	Treatment plant	Finished	Surface	0	4		
	6/12	Reservoir	Raw	Ground	0	3		
	6/12	Well	Raw	Ground	5	0	.2	
Garden City	6/6–6/19	Treatment plant	Finished	Surface	0	7		
Gladstone	6/19	Treatment plant	Finished	Ground	0	5		
Greenwood	6/5–6/18	Treatment plant	Finished	Surface	0	9		
Harrisonville	6/5–6/19	Treatment plant	Finished	Surface	0	7		
Independence	6/16	Treatment plant	Raw	Ground	3	11		0
	6/12	Treatment plant	Finished	Ground	0	6		
Kansas City	6/12–6/25	Treatment plant	Finished	Surface	0	6		
Kearney	6/13	Distribution system	Finished	Other	0	0		
	6/13	Treatment plant	Finished	Ground	0	3		
Lee's Summit	6/16–6/30	Treatment plant	Finished	Surface	0	7		
Liberty	6/19	Treatment plant	Finished	Ground	0	3		
	6/19	Treatment plant	Finished	Ground	0	0		
Mosby	6/19	Treatment plant	Finished	Ground	0	0		
North Kansas City	6/19	Treatment plant	Raw	Ground	4	7		
Oak Grove	6/16–6/29	Treatment plant	Finished	Surface	0	5		
Parkville	6/17–7/1	Treatment plant	Finished	Ground	0	7		
Peculiar	6/5–6/18	Treatment plant	Finished	Surface	0	6		
Platte City	6/16–7/1	Treatment plant	Finished	Ground	0	5		
	6/16	Treatment plant	Finished	Ground	0	3		
Pleasant Hill	6/6–6/20	Treatment plant	Finished	Surface	0	8		
Raymore	6/5–6/18	Treatment plant	Finished	Surface	0	9		
Smithville	6/13–6/26	Treatment plant	Finished	Surface	0	9		
Tracy	6/18	Treatment plant	Finished	Ground	0	5		
Waldron	6/18	Treatment plant	Finished	Ground	0	5		
Weston	6/17	Treatment plant	Finished	Ground	0	6		

[a] The locations shown are the mailing aldresses for the community from which the water supply was sampled.

[b] The minimum detectable radioactivity is 2 pCi/liter for gross alpha, gross beta, and strontium-90; and 0.1 pCi/liter for radium-226. All values equal to or less than the minimum detectable concentration have been reported as zero.

(3) McCABE, L. J., J. M. SYMONS, R. D. LEE, and G. G. ROBECK. Survey of community water supply systems. JAWWA 62:670–687 (1970).

(4) DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, BUREAU OF WATER HYGIENE. Community water supply study, State of Vermont (1970).

(5) DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, BUREAU OF WATER HYGIENE. Community water supply study, New York standard metropolitan statistical area (June 1970).

(6) DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, BUREAU OF WATER HYGIENE. Community water supply study, Charleston, West Virginia standard metropolitan statistical area (June 1970).

(7) DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, BUREAU OF WATER HYGIENE. Community water supply study, Charleston, South Carolina standard metropolitan statistical area (1970).

Table 7. Radioactivity in community water supplies, 1969, New Orleans, Louisiana SMSA

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
Louisiana:								
Abita Springs	6/25	Well	Raw	Ground	0	0		
	6/25	Well	Raw	Ground	0	0		
	6/24	Well	Raw	Ground	0	0		
Chalmette	6/19–7/2	Treatment plant	Finished	Surface	0	6	0	0
Covington	6/23	Reservoir	Finished	Ground	0	0		
	6/23	Well	Finished	Ground	0	0		
	6/24	Well	Finished	Ground	0	0		
	6/24	Well	Finished	Ground	0	0		
	6/24	Well	Finished	Ground	0	0		
	6/23	Well	Finished	Ground	0	0		
	6/24	Well	Finished	Ground	0	0		
	6/23	Well	Raw	Ground	0	0		
Grand Isle	6/18	Reservoir	Finished	Surface	0	5		
Gretna	6/16–6/29	Treatment plant	Finished	Surface	0	5	0	0
Madisonville	6/23	Well	Other	Ground	0	0		
Mandeville	6/23	Well	Finished	Ground	0	0		
	6/25	Well	Finished	Ground	0	0		
	6/24	Well	Finished	Ground	0	0		
	6/24	Well	Finished	Ground	0	0		
New Orleans	6/20–7/3	Treatment plant	Finished	Surface	0	5		
	6/19–7/2	Treatment plant	Finished	Surface	0	5		
	6/23–7/6	Treatment plant	Finished	Surface	0	5		
	6/20	Reservoir	Finished	Ground	0	6	0	0
Pearl River	6/24	Well	Raw	Ground	0	0		
	6/24	Well	Raw	Ground	0	0		
Slidell	6/24	Well	Other	Ground	0	0		
	6/24	Well	Other	Ground	0	0		
Sun	6/25	Distribution system	Finished	Ground	0	2		
Westwego	6/17–6/30	Treatment plant	Finished	Surface	0	8	0	0

[a] The locations shown are the mailing aldresses for the community from which the water supply was sampled.

[b] The minimum detectable radioactivity is 2 pCi/liter for gross alpha, gross beta, and strontium-90; and 0.1 pCi/liter for radium-226. All values equal to or less than the minimum detectable concentration have been reported as zero.

Table 8. Radioactivity in community water supplies, 1969, Colorado SMSA

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
Colorado:								
Beulah	6/17	Treatment plant	Finished	Surface	0	5		
	6/16	Distribution system	Raw	Surface	0	4		
Blende	6/12	Well	Finished	Ground	0	6		
Boone	6/16	Distribution system	Finished	Ground	5	5	0.4	
Colorado City	6/13	Well	Raw	Ground	13	10	2.1	
Pueblo	6/13–6/26	Treatment plant	Finished	Surface	0	5		
	6/10	Other	Raw	Ground	12	9	.2	
	6/10	Well	Finished	Ground	9	6	0	
	6/11	Well	Raw	Ground	22	55	5.4	0
	6/10	Distribution system	Finished	Ground	164	73	76.5	
	6/10	Well	Raw	Ground	3	5		
	6/11	Well	Raw	Ground	6	10	0	
	6/12	Reservoir	Finished	Ground	10	8	.2	
	6/11	Well	Finished	Ground	5	12	1.7	0
	6/9	Well	Finished	Ground	0	4		
	6/12	Reservoir	Finished	Ground	13	11	.2	0
	6/9	Well	Raw	Ground	28	57	5.4	0
	6/18	Well	Finished	Ground	21	26	4.6	0
	6/12	Well	Finished	Ground	14	42	2.2	0
	6/12	Well	Raw	Ground	7	7	0	
Rye	6/13	Well	Finished	Ground	377	154	136	
	6/13	Treatment plant	Raw	Surface	0	5		

[a] The locations shown are the mailing aldresses for the community from which the water supply was sampled.

[b] The minimum detectable radioactivity is 2 pCi/liter for gross alpha, gross beta, and strontium-90; and 0.1 pCi/liter for radium-226. All values equal to or less than the minimum detectable concentration have been reported as zero.

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Table 9. Radioactivity in community water supplies, 1969, San Bernardio-Riverside-Ontario, California SMSA

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
California:								
Adelanto	3/26	Well	Finished	Ground	0	63		0
	3/19	Other	Finished	Ground	0	10		
Alta Loma	3/27–4/10	Other	Raw	Surface	4	0	0	
Angelus Oaks	5/22	Distribution system	Finished	Ground	0	5		
Anza	4/16	Distribution system	Finished	Ground	0	3		
Apple Valley	4/9	Distribution system	Raw	Ground	0	0		
	4/16	Well	Other	Ground	14	5	0.2	
	3/26	Well	Raw	Ground	0	3		
	3/26	Well	Raw	Ground	3	0		
	3/26	Well	Raw	Ground	4	0	0	
	4/9	Reservoir	Raw	Ground	9	4	0	
	3/19	Well	Raw	Ground	0	3		
	3/19	Well	Raw	Ground	0	13		0
	3/19	Well	Raw	Ground	0	6		
	3/19	Well	Raw	Ground	4	19	.2	0
	3/24	Well	Raw	Ground	10	10	.2	0
	4/10	Well	Raw	Ground	0	0		
Arrowbear Lake	5/22	Reservoir	Raw	Ground	58	10	.6	
Arrowhead Springs	3/18	Distribution system	Finished	Ground	0	8		
Baker	4/7	Other	Raw	Ground	23	15	.2	0
	4/7	Well	Raw	Ground	0	3		
Banning	4/29	Distribution system	Finished	Ground	0	3		
	4/28–5/12	Distribution system	Finished	Surface	0	0		
Barstow	4/14	Well	Raw	Ground	8	29	.2	0
	4/15	Well	Raw	Ground	7	3	.3	
	4/7	Distribution system	Finished	Ground	0	0		
Beaumont	4/30	Distribution system	Finished	Surface	0	3		
	4/28	Reservoir	Raw	Ground	0	5		
	4/28	Reservoir	Raw	Ground	0	7		
	4/28	Reservoir	Raw	Ground	0	4		
Big Bear City	5/22	Reservoir	Finished	Ground	0	4		
Big Bear Lake	5/26	Distribution system	Finished	Ground	0	5		
	5/26	Distribution system	Finished	Ground	0	0		
	5/21	Reservoir	Raw	Ground	0	3		
Bloomington	3/20	Well	Raw	Ground	0	33		0
	3/20	Well	Finished	Ground	0	4		
	3/19	Distribution system	Finished	Ground	0	10		
Blue Jay	5/8	Well	Raw	Ground	10	6	.2	
	5/26	Distribution system	Finished	Ground	0	3		
Blythe	4/7	Well	Raw	Ground	0	0		
	3/28	Well	Raw	Ground	0	5		
	3/28	Well	Raw	Ground	0	0		
	4/7	Well	Raw	Ground	0	4		
Cabazon	4/28	Distribution system	Finished	Ground	5	0	0	
	5/7	Well	Raw	Ground	0	0		
	4/28	Other	Raw	Ground	3	20		0
Calimesa	4/28	Well	Raw	Ground	0	4		
	4/29	Well	Raw	Ground	0	5		
	4/29	Well	Finished	Ground	0	0		
	4/29	Well	Raw	Ground	0	16		0
	4/29	Well	Raw	Ground	0	5		
Cathedral City	4/18	Distribution system	Finished	Ground	3	3		
Cedar Glen	5/6	Well	Raw	Ground	0	0		
Cedarpines	5/1	Other	Raw	Ground	0	11	0	0
Cherry Valley	4/28	Well	Raw	Ground	0	5		
	4/28	Well	Raw	Ground	0	8		
	4/28	Well	Raw	Ground	0	0		
	4/28	Well	Raw	Ground	0	7		
Chino	3/20–4/3	Reservoir	Finished	Ground	0	3		
	3/26	Distribution system	Finished	Surface	0	6		
	3/20	Well	Finished	Ground	0	14		0
	3/27	Well	Finished	Ground	0	0		
Claremont	3/20	Well	Raw	Ground	0	13		0
Coachella	5/2	Well	Raw	Ground	0	8		
	5/2	Well	Raw	Ground	0	4		
	5/2	Well	Raw	Ground	0	5		
	5/2	Well	Raw	Ground	0	6		
	5/2	Well	Raw	Ground	3	4		
	5/5	Well	Raw	Ground	0	3		
	5/6	Well	Raw	Ground	0	4		
	5/6	Well	Raw	Ground	4	3	0	
	5/6	Well	Raw	Ground	5	5	0	
	5/8	Well	Raw	Ground	3	3		
	5/5	Well	Raw	Ground	3	8		
	5/6	Well	Finished	Ground	4	7	0	
	5/6	Well	Raw	Ground	3	6		
	5/6	Well	Raw	Ground	0	12		0
	5/5	Well	Finished	Ground	4	3	0	
	5/6	Well	Raw	Ground	0	7		
	5/7	Well	Raw	Ground	0	4		
	5/6	Well	Raw	Ground	3	4		
	5/8	Well	Raw	Ground	0	0		
	5/8	Well	Raw	Ground	0	3		
	5/8	Well	Raw	Ground	5	5	0	
	5/8	Well	Raw	Ground	0	3		
	5/8	Well	Raw	Ground	0	0		

See footnotes at end of table.

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Table 9. Radioactivity in community water supplies, 1969, San Bernardino-Riverside-Ontario, California SMSA —continued

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
California—continued								
Coachella—continued	5/7	Well	Raw	Ground	0	4		
	5/5	Well	Raw	Ground	4	4	0	
	5/7	Well	Raw	Ground	5	7	0.2	
	5/7	Well	Raw	Ground	0	0		
	5/7	Well	Raw	Ground	4	6	0	
	5/6	Well	Raw	Ground	4	4	0	
	5/6	Well	Raw	Ground	0	6		
	5/7	Well	Raw	Ground	4	9	.3	
	5/7	Well	Raw	Ground	5	3	3	
	5/5	Well	Finished	Ground	3	13	0	0
Colton	3/20	Well	Finished	Ground	0	8		
	3/21	Well	Finished	Ground	0	16		0
	3/17	Distribution system	Finished	Other	13	7	0	
	3/20	Distribution system	Finished	Ground	0	8		
	3/18	Well	Finished	Ground	23	6	0	
	3/28	Well	Finished	Ground	0	0		
Corona	4/8	Well	Finished	Ground	0	0		
	4/9–4/22	Treatment plant	Finished	Surface	3	11		0
	4/22	Distribution syctem	Finished	Ground	12	11	.2	0
Crestline	5/20	Well	Raw	Ground	0	3		
	5/9	Treatment plant	Finished	Ground	0	0		
	5/1	Other	Raw	Ground	0	4		
	5/20	Reservoir	Raw	Ground	0	0		
	5/7	Well	Finished	Ground	0	4		
	5/23	Reservoir	Raw	Ground	0	0		
Cucamonga	3/25–4/8	Reservoir	Finished	Surface	0	6		
	5/2	Distribution system	Finished	Ground	0	0		
Daggett	4/7	Well	Other	Ground	5	4		
Desert Center	4/10	Treatment plant	Finished	Ground	0	0		
Desert Hot Springs	4/17	Well	Finished	Ground	0	4		
	4/17	Reservoir	Raw	Ground	11	9	.2	
	4/17	Well	Raw	Ground	0	5		
	4/17	Reservoir	Raw	Ground	5	8	.2	
Devore	3/24	Other	Finished	Ground	0	7		
	3/24	Well	Finished	Ground	0	9		
Eagle Mountain	4/10	Other	Finished	Ground	0	6		
East Highlands	3/17	Well	Raw	Ground	28	10	.2	
Edgemont	4/14	Well	Raw	Combined	0	6		
Elsinore	4/10	Treatment plant	Finished	Combined	0	16		0
	4/10	Well	Raw	Ground	0	0		
	4/14	Well	Raw	Ground	0	6		
	4/14	Distribution system	Raw	Ground	0	7		
	4/10	Well	Finished	Ground	0	0		
	4/10	Well	Finished	Ground	0	0		
	4/10	Well	Finished	Ground	4	0		
	4/14–4/27	Treatment plant	Finished	Surface	0	0		
Etiwanda	5/1	Well	Raw	Ground	0	4		
Fawnskin	5/1	Well	Finished	Combined	7	3	0	
Fontana	5/2	Other	Finished	Surface	5	7	.3	
	5/6	Other	Raw	Ground	3	0		
	5/6	Well	Raw	Ground	4	3	0	
	5/6	Well	Finished	Ground	0	3		
	5/6	Well	Finished	Ground	5	0	0	
	5/6	Well	Finished	Ground	3	3		
Forest Falls	4/14	Distribution system	Finished	Ground	3	0		
	4/14	Distribution system	Finished	Ground	0	4		
	4/14	Well	Other	Ground	0	5		
	5/19	Distribution system	Finished	Ground	0	0		
Fredalba	5/23	Reservoir	Finished	Ground	0	0		
Glen Avon Heights	4/30	Well	Raw	Ground	0	3		
Green Valley Lake	5/1	Distribution system	Finished	Ground	33	16	.2	0
Havasu Lake	4/11	Well	Raw	Ground	0	8		
	4/15	Treatment plant	Finished	Surface	5	24	.3	0
Hemet	4/16	Distribution system	Finished	Ground	4	5	.4	
	4/15	Well	Finished	Ground	5	0	0	
	4/16–4/29	Treatment plant	Finished	Surface	10	13	.3	3
	4/16	Well	Raw	Ground	6	3	0	
	4/15	Well	Raw	Groond	0	8		
	4/16	Distribution system	Finished	Ground	0	4		
Hesperia	3/24	Well	Finished	Ground	0	8		
	3/24	Well	Finished	Ground	3	3		
	3/24	Well	Finished	Ground	0	0		
Highland	3/19	Well	Finished	Ground	0	11		0
	3/19	Treatment plant	Finished	Ground	11	11	.3	0
	3/28	Well	Finished	Ground	0	0		
Hinkley	4/8	Distriubtion system	Finished	Ground	9	4	0	
Idyllwild	5/28	Reservoir	Finished	Surface	0	0		
	5/29	Distribution system	Finished	Combined	0	0		
	5/29–6/12	Distribution system	Finished	Surface	10	16	4.6	0
	4/30	Distribution system	Finished	Ground	0	6		
Indio	5/8	Well	Raw	Ground	0	4		
	5/7	Well	Finished	Ground	5	0	0	
	5/5	Well	Raw	Ground	4	8	0	

See footnotes at end of table.

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Table 9. Radioactivity in community water supplies, 1969, San Bernardino-Riverside-Ontario, California SMSA —continued

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
California—continued								
Indio	4/16	Well	Raw	Ground	9	9	0	
	4/11	Well	Raw	Ground	4	3	0	
	5/19	Well	Raw	Ground	20	8	0	
	5/5	Well	Raw	Ground	6	4	0	
Johannesburg	4/7	Reservoir	Finished	Ground	0	0		
Joshua Tree	4/15	Well	Finished	Ground	0	5		
	4/9	Well	Raw	Ground	4	0	0	
Kramer Junction	4/8	Distribution system	Finished	Ground	13	8	0	
Lake Arrowhead	5/6–5/20	Treatment plant	Finished	Surface	0	5		
	5/29	Well	Raw	Ground	0	3		
	5/22	Well	Finished	Ground	0	0		
La Quinta	5/2	Distribution system	Finished	Ground	6	8	0	
	5/6	Well	Raw	Ground	0	0		
	5/3–5/17	Well	Finished	Ground	0	3		
	5/2	Well	Raw	Ground	0	0		
La Sierra	3/27	Well	Finished	Ground	9	6	0.3	
	3/27	Well	Finished	Ground	10	11	.2	0
	3/27	Well	Finished	Ground	6	8	.2	
Lenwood	4/9	Distribution system	Finished	Ground	18	4		
	4/15	Well	Finished	Ground	7	4	.3	
Little Morongo Heights	3/28	Well	Raw	Ground	44	21	.4	0
Loma Linda	4/14	Reservoir	Finished	Ground	0	0		
	4/14	Well	Finished	Ground	6	4	0	
	3/18	Well	Raw	Ground	0	0		
	3/18–3/25	Distribution system	Finished	Ground	4	5	0	
	4/14	Reservoir	Finished	Ground	0	0		
Lucerne Valley	4/10	Reservoir	Other	Ground	6	0	0	
	4/10	Distribution system	Finished	Ground	0	0		
	4/10	Distribution system	Finished	Ground	4	0		
	4/9	Well	Finished	Ground	4	4		
	3/25	Well	Finished	Ground	0	17		0
	3/24	Distribution system	Finished	Ground	0	14		0
	3/20	Well	Raw	Ground	0	7		
	3/25	Well	Finished	Ground	0	14		0
	3/20	Well	Raw	Ground	3	3		
Lytle Creek	5/23	Well	Finished	Ground	0	6		
Mecca	5/8	Well	Finished	Ground	0	0		
Mentone	4/9	Distribution system	Finished	Ground	0	0		
	5/19	Distribution system	Finished	Ground	4	3	0	
Mira Loma	4/30	Reservoir	Finished	Ground	0	3		
	4/30	Well	Finished	Ground	4	3	0	
	5/5	Well	Raw	Ground	5	9	0	
Montclair	3/21	Distribution system	Raw	Ground	0	5		
Morongo Valley	4/16	Distribution system	Finished	Ground	18	16	0	0
	4/7	Well	Raw	Ground	14	6	0	
Mountain Center	4/11	Well	Raw	Ground	0	0		
Mt. Baldy	5/20	Distribution system	Finished	Ground	0	4		
	5/19	Distribution system	Finished	Ground	0	0		
	5/27	Distribution system	Finished	Surface	0	0		
Murrieta	4/16	Well	Raw	Ground	0	0		
Muscoy	3/18	Well	Raw	Ground	0	0		
Needles	3/21	Well	Raw	Ground	8	20	0	0
Newberry	4/11	Distribution system	Finished	Ground	8	13	.3	0
Nipton	4/28	Distribution system	Finished	Ground	19	6	0	
Norco	5/6	Well	Raw	Ground	8	3	0	
Nuevo	4/10	Distribution system	Finished	Ground	0	3		
Ontario	3/25	Reservoir	Partially treated	Ground	0	6		
Oro Grande	4/9	Well	Raw	Ground	4	7		
	4/9	Well	Raw	Ground	0	3		
Palm Desert	5/8	Well	Raw	Ground	3	0		
	5/8	Well	Raw	Ground	0	6		
	4/17	Well	Finished	Ground	0	3		
	5/8	Well	Raw	Ground	0	4		
	4/18	Reservoir	Finished	Ground	8	6	0	
Palm Springs	4/29	Well	Finished	Ground	5	4	0	
	4/17–5/1	Reservoir	Raw	Ground	0	0		
	4/18	Well	Raw	Ground	0	10		
Parker Dam	3/24	Well	Raw	Ground	4	7	0	
	3/25–4/7	Treatment plant	Finished	Surface	7	7	.2	
	3/24	Other	Raw	Surface	5	22	.3	4
Perris	4/17	Distribution system	Finished	Combined	3	10		
Phelan	4/10	Other	Raw	Ground	0	6		
Pinon Hills	4/10	Other	Raw	Ground	3	0		
Pioneertown	4/9	Distribution system	Finished	Cround	5	4	0	
Ranch Mirage	4/18	Distribution system	Fihished	Ground	0	8		
Redlands	4/29–5/14	Treatment plant	Finished	Surface	0	3		
	4/29	Well	Raw	Ground	10	4	0	
	4/29	Well	Finished	Ground	0	0		
Rialto	3/24	Well	Raw	Ground	6	8	0	
	3/28	Well	Raw	Ground	0	0		
Rim Forest	5/21	Distribution system	Other	Ground	0	0		
	5/23	Distribution system	Other	Ground	0	0		
	5/27	Well	Raw	Ground	0	0		
	5/27	Distribution system	Finished	Ground	0	0		

See footnotes at end of table.

Table 9. Radioactivity in community water supplies, 1969, San Bernardino-Riverside-Ontario, California SMSA —continued

Location[a]	Collection date (1969)	Sampled from	Water type	Source	Concentration[b] (pCi/liter)			
					Gross alpha	Gross beta	^{226}Ra	^{90}Sr
California—continued								
Riverside	5/1	Other	Finished	Ground	11	3	0	
	5/1	Well	Raw	Ground	0	5		
	5/1	Well	Raw	Ground	0	9		
	5/1	Well	Raw	Ground	14	6	0	
	4/30	Well	Raw	Ground	26	11	0	0
	4/18-30	Treatment plant	Finished	Surface	17	12	0.3	0
	3/26-4/10	Distribution system	Finished	Ground	10	4	0	
	3/26	Well	Raw	Ground	0	0		
	4/8	Well	Raw	Ground	7	6	0	
	4/10	Reservoir	Raw	Ground	5	0	0	
	4/30	Well	Finished	Ground	0	0		
	4/30	Well	Raw	Ground	14	4	0	
	5/8	Distribution system	Finished	Surface	0	12		0
	5/8	Distribution system	Finished	Ground	0	10		
Rubidoux	4/9	Well	Raw	Ground	10	4	0	
	4/9	Well	Raw	Ground	10	6		
Runnings Springs	5/1-5/14	Treatment plant	Finished	Surface	0	3		
San Bernardino	3/21	Distribution system	Finished	Ground	4	4		
	3/18	Well	Finished	Ground	0	0		
	3/18	Well	Raw	Ground	0	0		
	3/18	Well	Raw	Ground	3	7		
	4/15	Distribution system	Finished	Ground	7	11	.2	0
	4/14	Reservoir	Finished	Ground	0	3		
	4/15-4/28	Reservoir	Finished	Combined	0	5		
	4/7	Well	Raw	Ground	0	0		
	4/8	Well	Raw	Ground	7	0	0	
	3/28	Distribution system	Finished	Ground	0	5		
	3/19	Well	Raw	Ground	0	13		0
	3/19	Well	Raw	Ground	0	8		
	3/19	Well	Finished	Ground	8	7	.2	
	3/24	Distribution system	Finished	Ground	0	0		
	3/25	Distribution system	Finished	Ground	0	0		
	3/17-3/31	Distribution system	Finished	Ground	0	0		
	3/17	Well	Raw	Ground	5	3	0	
	3/17	Distribution system	Finished	Ground	0	0		
	3/19	Distribution system	Finished	Ground	0	26		0
	3/17	Well	Finished	Ground	0	0		
	3/19	Reservoir	Finished	Ground	6	20	0	0
San Jacinto	4/16	Well	Raw	Ground	0	4		
	4/16	Well	Raw	Ground	0	3		
Skyforest	5/5	Well	Finished	Ground	22	11	.3	0
	5/26	Distribution system	Finished	Ground	0	0		
Sleepy Hollow	3/27	Distribution system	Finished	Ground	0	0		
Sunnymead	4/10	Well	Raw	Ground	0	0		
	4/15	Well	Other	Ground	0	16		0
Temecula	4/16	Well	Finished	Ground	0	0		
	4/16	Well	Finished	Ground	19	7	0	
	4/16	Well	Finished	Ground	0	0		
Thermal	5/7	Well	Raw	Ground	5	8	0	
Trona	5/5	Distribution system	Finished	Ground	0	0		
	5/5	Distribution system	Finished	Ground	5	7	0	
Twentynine Palms	4/15	Well	Finished	Ground	6	6	0	
Twin Peaks	5/26	Well	Raw	Ground	7	7	.2	
	5/21	Reservoir	Raw	Ground	0	4		
	5/28	Well	Raw	Ground	0	3		
Upland	3/21	Well	Raw	Ground	0	6		
	3/27	Well	Raw	Ground	0	0		
	3/20	Other	Raw	Ground	0	13		0
Victorville	3/20	Well	Raw	Ground	0	17		0
	3/27	Well	Raw	Ground	0	3		
	3/27	Well	Raw	Ground	0	0		
	3/27	Well	Raw	Ground	0	0		
West Palm Springs	4/17	Well	Other	Ground	0	3		
West Riverside	4/9	Well	Raw	Ground	0	6		
Wrightwood	4/11	Well	Other	Ground	0	3		
Yermo	4/9	Well	Partially treated	Ground	11	4	.2	
	4/7	Well	Raw	Ground	13	6	0	
	4/7	Well	Raw	Ground	15	5	.2	
	4/7	Well	Raw	Ground	16	4	0	
Yucaipa	3/21	Reservoir	Finished	Ground	0	7		
	3/27	Distribution system	Finished	Ground	0	0		
	5/21	Distribution system	Finished	Other	0	0		
	3/18	Distribution system	Finished	Ground	0	0		
Yucca Valley	4/8	Well	Other	Ground	18	7		
	4/11	Well	Raw	Ground	4	10	0	
	4/15	Well	Raw	Ground	0	5		
	4/15	Well	Raw	Ground	0	8		

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[a] The locations shown are the mailing addresses for the community from which the water supply was sampled.

[b] The minimum detectable radioactivity is 2 pCi/liter for gross alpha, gross beta, and strontium-90; and 0.1 pCi/liter for radium-226. All values equal to or less than the minimum detectable concentration have been reported as zero.

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Table 10. Summary of radiological analyses [a] for each SMSA and Vermont

Location	Gross alpha				Gross beta			
	Number of samples	Number of samples >3 pCi/liter	Range (pCi/liter)	Average (pCi/liter)	Number of samples	Number of samples >10 pCi/liter	Range (pCi/liter)	Average (pCi/liter)
State of Vermont	261	14	0–20	0.5	261	0	0–10	2.1
New York, N.Y. SMSA	254	3	0–8	.1	254	4	0–23	1.5
Charleston, W. Va. SMSA	27	0	0	0	27	0	0–7	1.7
Charleston, S.C. SMSA	20	0	0	0	20	11	0–40	10.7
Cincinnati, Ohio-Ky.-Ind. SMSA	44	0	0–3	.1	44	0	0–7	.3
Kansas City, Mo.-Kans. SMSA	56	3	0–6	.4	56	5	0–23	5.4
New Orleans, La. SMSA	29	0	0	0	29	0	0–6	1.7
Pueblo, Colo. SMSA	22	15	0–377	32.2	22	8	4–154	23.6
San Bernardino-Riverside-Ontario, Calif. SMSA	330	110	0–58	3.4	330	43	0–63	5.3
Summary	1,043	145	0–377	1.9	1,043	71	0–154	3.7

Location	Radium-226				Strontium-90			
	Number of samples	Number of samples >3 pCi/liter	Range (pCi/liter)	Average (pCi/liter)	Number of samples	Number of samples >10 pCi/liter	Range (pCi/liter)	Average (pCi/liter)
State of Vermont	14	0	0–2.7	0.8	0	0	0	0
New York, N.Y. SMSA	1	0	0	0	2	0	0	0
Charleston, W. Va. SMSA	2	0	0	0	3	0	0	0
Charleston, S.C. SMSA	2	0	0	0	7	0	0	0
Cincinnati, Ohio-Ky.-Ind. SMSA	0	0	0	0	0	0	0	0
Kansas City, Mo.-Kans. SMSA	2	1	0.2–4.3	2.3	5	0	0	0
New Orleans, La. SMSA	4	0	0	0	4	0	0	0
Pueblo, Colo. SMSA	15	5	0–136	15.7	6	0	0	0
San Bernardino-Riverside-Ontario, Calif. SMSA	103	1	0–4.6	.1	44	0	0–4	0.2
Summary	143	7	0–136	1.8	71	0	0–4	0.1

[a] The minimum detectable radioactivity is 2 pCi/liter for gross alpha, gross beta, and strontium-90; and 0.1 pCi/liter for radium-226. All values equa to or less than the minimum detectable concentration have been reported as zero.

(8) DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, BUREAU OF WATER HYGIENE. Community water supply study, Cincinnati, Ohio standard metropolitan statistical area (1970).

(9) DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, BUREAU OF WATER HYGIENE. Community water supply study, Kansas City, Kansas-Missouri standard metropolitan statistical area (1970).

(10) DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, BUREAU OF WATER HYGIENE. Community water supply study, New Orleans, Louisiana standard metropolitan statistical area (1970).

(11) DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, BUREAU OF WATER HYGIENE. Community water supply study, Pueblo County, Colorado standard metropolitan statistical area (June 1970).

(12) DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE, BUREAU OF WATER HYGIENE. Community water supply study, San Bernardino-Riverside-Ontario, California standard metropolitan statistical area (1970).

(13) U.S. PUBLIC HEALTH SERVICE, BUREAU OF RADIOLOGICAL HEALTH. Tritium in community water supplies, 1969. Radiol Health Data Rep 11:692–694 (December 1970).

(14) INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION. Recommendations of the International Commission on Radiological Protection. Report of Committee II on Permissible Dose for Internal Radiation (1959).

(15) NATIONAL COUNCIL ON RADIATION PROTECTION AND MEASUREMENTS. Basic Radiation Protection Criteria, NCRP Report No. 39. National Council on Radiation Protection and Measurements, Washington, D.C. 20008 (January 15, 1971).

(16) FEDERAL RADIATION COUNCIL. Background material for the development of Radiation Protection Standards, Report No. 2. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (September 1961).

SECTION III. AIR AND DEPOSITION

Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta radioanalysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the Environmental Protection Agency, the Canadian Department of National Health and Welfare, the Mexican National Institute of Nuclear Energy, and the Pan American Health Organization.

In addition to those programs presented in this issue, the following programs were previously covered in *Radiation Data and Reports*.

Network	Period	Issue
Fallout in the United States and Other Areas, *HASL*	January-December 1970	December 1971
Mexican Air Monitoring Program	February-December 1971	May 1972
Plutonium in Airborne Particulates	October-December 1971	July 1972
Surface Air Sampling Program; 80th Meridian Network, *HASL*	January-December 1969	February 1972

1. Radiation Alert Network
May 1972

Division of Atmospheric Surveillance
Environmental Protection Agency

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Alert Network (RAN) which regularly gathers samples at 70 locations distributed throughout the country (figure 1). Most of the stations are operated by State health department personnel.

The station operators perform "field estimates" on the airborne particulate samples at 5 hours after collection, when most of the radon daughter products have decayed, and at 29 hours after collection, when most of the thoron daughter products have decayed. They also perform field estimates on dried precipitation samples and report all results to appropriate Environmental Protection Agency officials by mail or telephone depending on levels found. A compilation of the daily field estimates is available upon request from the Air Quality Information Systems Branch, Division of Atmospheric Surveillance, EPA, Research Triangle Park, N.C. 27711. A detailed description of the sampling and analytical procedures was presented in the March 1968 issue of *Radiological Health Data and Reports.*

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate technique, during May 1972.

One station reported a high reading in a single sample of precipitation for May: Jacksonville, Fla.—23 nCi/m² on May 30. All other field estimates reported were within normal limits for the reporting station.

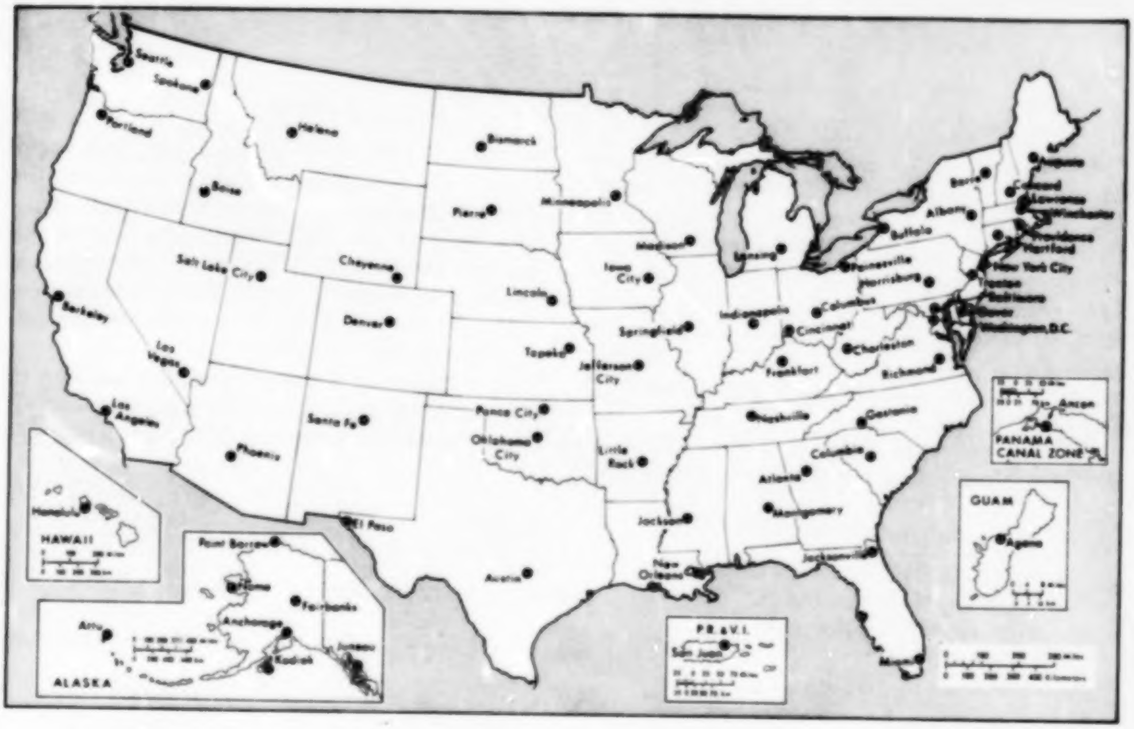
Seattle
Spokane
Portland
Helena
Bismarck
Boise
Pierre
Minneapolis
Salt Lake City
Cheyenne
Lincoln
Berkeley
Denver
Las Vegas
Topeka
Jefferson City
Los Angeles
Santa Fe
Ponca City
Oklahoma City
Phoenix
Little Rock
Honolulu
HAWAII
El Paso
Point Barrow
Nome
Fairbanks
Anchorage
Attu
Juneau
Kodiak
ALASKA
Austin
Madison
Iowa City
Lansing
Springfield
Indianapolis
Cincinnati
Columbus
Frankfort
Charleston
Richmond
Nashville
Gastonia
Columbia
Atlanta
Montgomery
Jackson
New Orleans
Jacksonville
Miami
Augusta
Barre
Concord
Lawrence
Albany
Buffalo
Providence
Hartford
Painesville
Harrisburg
New York City
Trenton
Baltimore
Dover
Washington, D.C.
Ancon
PANAMA CANAL ZONE
GUAM
Agana
PR & V.I.
San Juan

Figure 1. Radiation Alert Network sampling stations

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Table 1. Gross beta radioactivity in surface air and precipitation, May 1972

Station location		Number of samples	Gross beta radioactivity (5-hour field estimate) (pCi/m³)			Precipitation				
						Number of samples	Total depth (mm)	Field estimation of deposition		
			Maximum	Minimum	Average[a]			Number of samples	Depth (mm)	Total deposition (nCi/m²)
Ala:	Montgomery	19	2	0	1	3	46	3	46	17
Alaska:	Anchorage	2	0	0	0	0				
	Attu Island	0				0				
	Fairbanks	0				0				
	Juneau	1	2	2	2	0				
	Kodiak	0				0				
	Nome	0				0				
	Point Barrow	0				0				
Ariz:	Phoenix	22	6	1	3	0				
Ark:	Little Rock	20	2	0	1	0				
Calif:	Berkeley	22	1	0	0	0				
	Los Angeles	22	1	0	1	0				
C.Z:	Ancon	17	0	0	0	0				
Colo:	Denver	20	6	1	2	4	17	(b)		
Conn:	Hartford	22	1	0	0	11	101	11	101	0
Del:	Dover	21	1	0	0	0				
D.C:	Washington	26	1	0	0	0				
Fla:	Jacksonville	22	1	0	0	8	183	8	183	41
	Miami	6	0	0	0	2	65	2	65	0
Ga:	Atlanta	22	2	0	1	0				
Guam:	Agana	0				0				
Hawaii:	Honolulu	22	1	0	0	0		(b)		
Idaho:	Boise	10	3	0	1	1	78	1	78	10
Ill:	Springfield	15	8	0	2	0				
Ind:	Indianapolis	21	2	0	1	0				
Iowa:	Iowa City	19	4	0	1	4	84	4	84	5
Kans:	Topeka	21	3	0	1	8	104	8	104	14
Ky:	Frankfort	0				0				
La:	New Orleans	21	0	0	0	6	176	(b)		
Maine:	Augusta	13	1	0	0	3	17	3	17	0
Md:	Baltimore	20	2	0	0	7	63	7	63	0
Mass:	Lawrence	22	1	0	0	7	109	7	109	0
	Winchester	20	1	0	0	8	127	8	127	0
Mich:	Lansing	20	1	0	0	7	47	7	47	8
Minn:	Minneapolis	22	3	0	1	6	68	6	68	11
Miss:	Jackson	17	2	0	1	5	117	5	117	2
Mo:	Jefferson City	21	7	0	2	4	61	4	61	0
Mont:	Helena	20	3	0	1	5	28	5	28	0
Nebr:	Lincoln	19	7	1	2	4	78	4	78	15
Nev:	Las Vegas	21	2	1	1	0				
N.H:	Concord	0				0				
N.J:	Trenton	21	1	0	0	10	124	10	124	7
N. Mex:	Santa Fe	21	3	1	1	0				
N.Y:	Albany	16	1	0	0	0				
	Buffalo	22	2	0	1	0				
	New York City	0				0				
N.C:	Gastonia	21	7	0	2	4	67	(b)		
N. Dak:	Bismarck	21	6	0	2	8	94	8	94	12
Ohio:	Cincinnati	0				0				
	Columbus	4	1	1	1	0				
	Painesville	21	1	0	0	10	81	10	81	21
Okla:	Oklahoma City	11	3	1	1	1	47	1	47	0
	Ponca City	21	6	0	2	4	50	4	50	0
Oreg:	Portland	19	1	0	0	8	74	8	74	4
Pa:	Harrisburg	17	2	0	0	1	8	1	8	3
P.R:	San Juan	0			0		(b)			
R.I:	Providence	21	1	0	0	1	2	1	2	0
S.C:	Columbia	12	6	0	1	9	138	9	138	0
S. Dak:	Pierre	22	3	0	1	0				
Tenn:	Nashville	19	3	0	1	6	79	6	79	6
Tex:	Austin	21	7	0	2	0				
	El Paso	9	4	1	1	0				
Utah:	Salt Lake City	30	2	0	1	2	5	2	5	1
Vt:	Barre	22	3	1	1	9	72	9	72	7
Va:	Richmond	19	0	0	0	1	8	1	8	4
Wash:	Seattle	9	0	0	0	2	10	(b)		
	Spokane	20	2	0	1	0				
W. Va:	Charleston	21	3	0	1	12	69	12	69	13
Wisc:	Madison	21	2	0	1	6	68	6	68	5
Wyo:	Cheyenne	22	10	0	3	3	23	3	23	10
Network summary		1,091	10	0	1	200	78	6	70	7

[a] The monthly average is calculated by weighting the field estimates of individual air samples with length of sampling period.
[b] This station is part of the tritium surveillance system. No gross beta measurements are done.

2. Canadian Air and Precipitation Monitoring Program,[1] May 1972

Radiation Protection Division
Department of National Health and Welfare

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 2), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*1–5*).

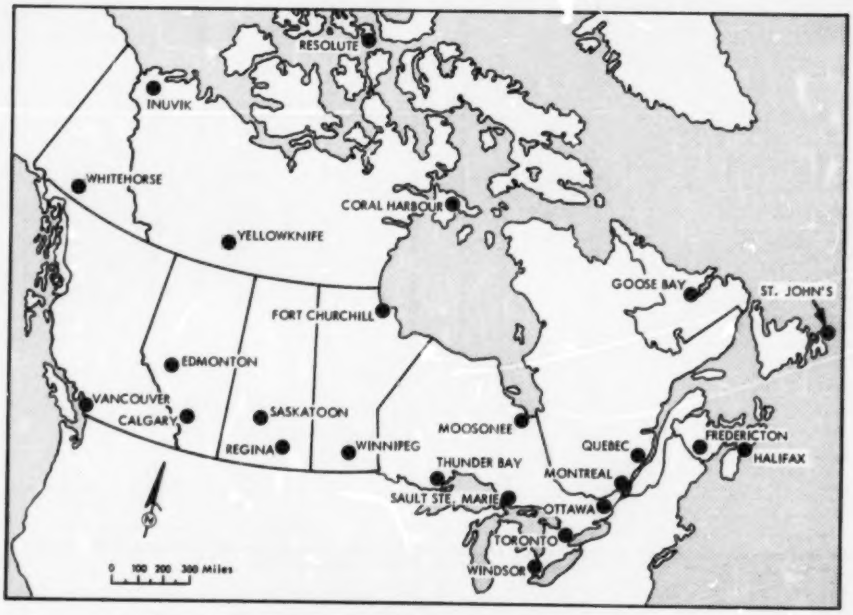
A summary of the sampling procedures and methods of analysis was presented in the May 1969 issue of *Radiological Health Data and Reports.*

Surface air and precipitation data for May 1972 are presented in table 2.

Table 2. Canadian gross beta radioactivity in surface air and precipitation, May 1972

Station	Number of samples	Air surveillance gross beta radioactivity (pCi/m³)			Precipitation measurements	
		Maximum	Minimum	Average	Average concentration (pCi/liter)	Total deposition (nCi/m²)
Calgary	5	0.2	0.0	0.1	33	1.0
Coral Harbour	5	.1	.0	.0	21	.5
Edmonton	5	.2	.0	.1	163	7.2
Ft. Churchill	5	.1	.0	.1	89	4.3
Fredericton	4	.1	.1	.1	40	3.3
Goose Bay	5	.1	.0	.0	77	2.9
Halifax	3	.1	.0	.1	50	8.1
Inuvik	5	.0	.0	.0	143	2.1
Montreal	5	.1	.1	.1	104	7.1
Moosonee	5	.1	.1	.1	(a)	8.9
Ottawa	5	.1	.1	.1	61	3.2
Quebec	5	.1	.0	.1	60	5.4
Regina	5	.2	.1	.1	96	6.9
Resolute	5	.1	.0	.1	19	.1
St. John's, Nfld	5	.1	.0	.1	51	3.9
Saskatoon	5	.2	.1	.1	111	4.6
Sault Ste. Marie	5	.2	.1	.1	89	4.8
Thunder Bay	5	.1	.0	.1	53	2.4
Toronto	5	.1	.1	.1	85	4.1
Vancouver	5	.1	.0	.1	247	7.9
Whitehorse	5	.1	.0	.1	86	2.8
Windsor	5	.1	.1	.1	108	5.8
Winnipeg	5	.1	.1	.1	220	6.3
Yellowknife	5	.0	.0	.0	NS	NS
Network summary	117	0.2	0.0	0.1	91	4.5

[a] Precipitation, <0.3 inches. NS, no sample.



RESOLUTE
INUVIK
WHITEHORSE
CORAL HARBOUR
YELLOWKNIFE
GOOSE BAY
ST. JOHN'S
FORT CHURCHILL
EDMONTON
VANCOUVER
CALGARY
SASKATOON
MOOSONEE
REGINA
WINNIPEG
QUEBEC
FREDERICTON
HALIFAX
THUNDER BAY
MONTREAL
SAULT STE. MARIE
OTTAWA
TORONTO
WINDSOR
0 100 200 300 Miles
N

Figure 2. Canadian air and precipitation sampling stations

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[1] Prepared from information and data obtained from the Canadian Department of National Health and Welfare, Ottawa, Canada.

3. Pan American Air Sampling Program
May 1972

Pan American Health Organization and
U.S. Environmental Protection Agency

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the U.S. Environmental Protection Agency (EPA) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 3. Analytical techniques were described in the March 1968 issue of *Radiological Health Data and Reports*. The May 1972 air monitoring results from the participating countries are given in table 3.

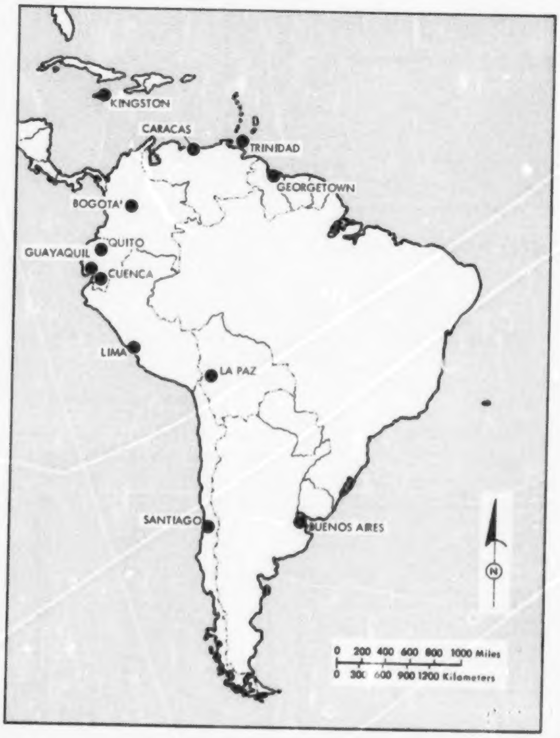

Figure 3. Pan American Air Sampling Program stations

Table 3. Summary of gross beta radioactivity in Pan American surface air, May 1972

Station location		Number of samples	Gross beta radioactivity (pCi/m³)		
			Maximum	Minimum	Average[a]
Argentina:	Buenos Aires	0			
Bolivia:	La Paz	0			
Chile:	Santiago	31	0.13	0.01	0.06
Colombia:	Bogota	21	0.3	.00	.00
Ecuador:	Cuenca	0			
	Guayaquil	9	.08	.03	.05
	Quito	0			
Guyana:	Georgetown	0			
Jamaica:	Kingston	0			
Peru:	Lima	0			
Venezuela:	Caracas	13	.11	.00	.03
West Indies:	Trinidad	13	.44	.05	.14
Pan American summary		87	.44	.00	.05

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Values less than 0.005 pCi/m³ are reported and used in averaging as 0.00 pCi/m³.

4. California Air Sampling Program
May 1972

Bureau of Radiological Health
California State Department of Public Health

The Bureau of Radiological Health of the California State Department of Public Health with the assistance of several cooperating agencies and organizations operates a surveillance system for determining radioactivity in airborne particulates. The air sampling locations are shown in figure 4.

All air samples are sent to the Sanitation and Radiation Laboratory of the State Department of Public Health where they are analyzed for their radioactive content.

Airborne particles are collected by a continu-

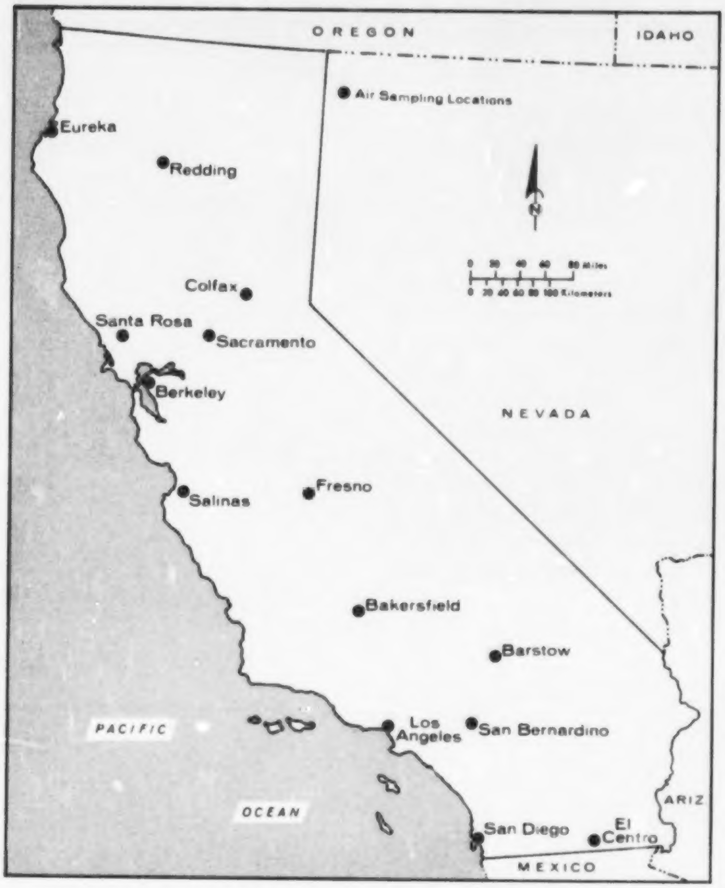
OREGON
IDAHO
Air Sampling Locations
N
0 20 40 60 80 Miles
0 20 40 60 80 100 Kilometers
Eureka
Redding
Colfax
Santa Rosa
Sacramento
Berkeley
NEVADA
Salinas
Fresno
Bakersfield
Barstow
PACIFIC
Los Angeles
San Bernardino
OCEAN
ARIZ
San Diego
El Centro
MEXICO

Figure 4. California Air Sampling Program stations

ous sampling of air filtered through a 47 millimeter membrane filter, 0.8 micron pore size, using a Gast air pump of about 2 cubic feet per minute capacity, or 81.5 cubic meters per day. Air volumes are measured with a direct reading gas meter. Filters are replaced every 24 hours except on holidays and weekends. The filters are analyzed for gross alpha and beta radioactivity 72 hours after the end of the collection period. The daily samples are then composited into a monthly sample for gamma spectroscopy and an analysis for strontium-89 and strontium-90. Table 4 presents the monthly gross beta radioactivity in air for May 1972. The monthly sample results are presented quarterly.

Table 4. Gross beta radioactivity in California air May 1972

Station location	Number of samples	Gross beta radioactivity[a] (pCi/m³)		
		Maximum	Minimum	Average
Bakersfield	31	1.16	0.08	0.40
Barstow	31	4.42	.13	.72
Berkeley	30	.88	.01	.19
Colfax	31	.68	.07	.34
El Centro	31	2.66	.04	.75
Eureka	28	.54	.04	.11
Fresno	30	.95	.11	.45
Los Angeles	30	.75	.06	.26
Redding	31	.80	.10	.39
Sacramento	28	1.41	.05	.36
Salinas	31	.62	.12	.28
San Bernardino	31	1.03	.19	.43
San Diego	30	.46	.06	.27
Santa Rosa	31	.69	.02	.20
Summary	424	4.42	0.01	0.47

[a] Single sample taken at Orange, Calif., May 15, 1972, resulted in a gross beta activity of 0.17. This sample is not included in summary.

5. Mexican Air Monitoring Program January–April 1972

Instituto Nacional de Energía Nuclear
México, D.F.

Until December 1971, the Radiation Surveillance Network of Mexico was operated by the Comision Nacional de Energía Nuclear (CNEN). In December 1971, the CNEN became the Instituto Nacional de Energía Nuclear (INEN), as a result of a new law passed by Congress.

In the Instituto Nacional de Energía Nuclear, the Comite de Seguridad Radiológica (Radiological Security Committee) (CSR) is responsible for radiological protection. The Environmental Radioactivity Section (Sección de Radioactividad Ambiental) of the CSR is in charge of monitoring and measuring environmental radioactive contamination in general, including radiation in mines, uranium milling plant and the Nuclear Center of Mexico.

Table 5. Mexican gross beta radioactivity of airborne particulates, January–April 1972

Station	Gross beta radioactivity (pCi/m³)			
	January	February	March	April
Chihuahua:				
Maximum	0.75	0.63	<0.20	0.54
Minimum	<.20	<.20	<.20	<.20
Average	.21	.25	<.20	.32
Ensenada:				
Maximum	.67	.87	NS	<.20
Minimum	<.20	<.20	NS	<.20
Average	<.20	<.20	NS	<.20
Mérida:				
Maximum	.30	.56	<.20	.64
Minimum	<.20	<.20	<.20	<.20
Average	<.20	<.20	<.20	<.20
México, D.F:				
Maximum	<.20	NS	<.20	<.20
Minimum	<.20	NS	<.20	<.20
Average	<.20	NS	<.20	<.20
Torreón:				
Maximum	<.20	NS	<.20	.61
Minimum	<.20	NS	<.20	<.20
Average	<.20	NS	<.20	<.20
Veracruz:				
Maximum	NS	NS	<.20	<.20
Minimum	NS	NS	<.20	<.20
Average	NS	NS	<.20	<.20

NS, no sample.

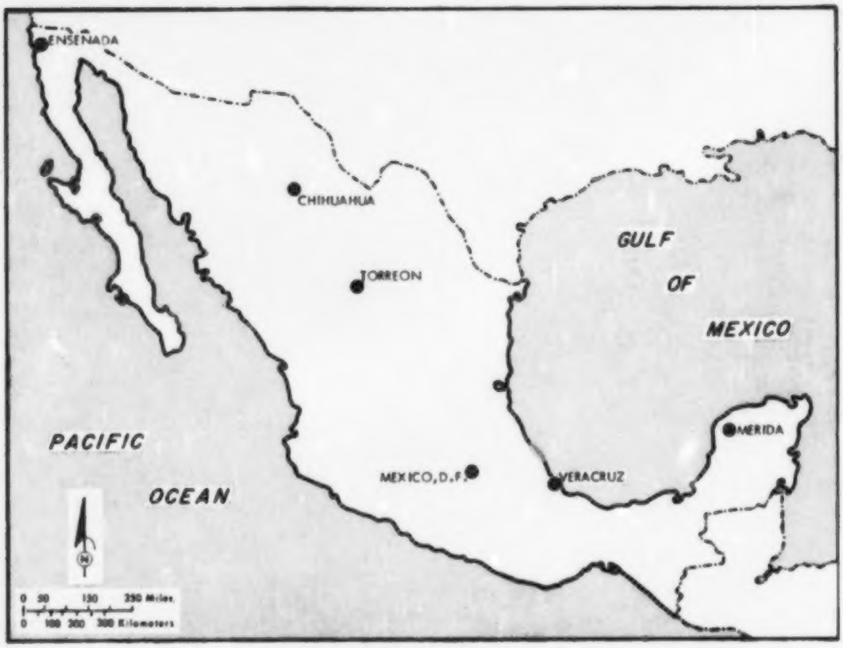

Figure 5. Mexican air sampling locations

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Since radioactivity in air particulates have decreased to very low levels in the past few years, the objective of the air monitoring program has been changed from an alert type of network to emphasize dose assessment.

Measurements will continue in the following 6 areas: México City, D.F.; Chihuahua; Ensenada; Torreón; Veracruz; and Mérida (figure 5). The sampling and analysis procedures were described previously (*6*).

The maximum, minimum, and average beta radioactivity in surface air from January through April 1972 are presented in table 5. Statistically it has been found that a minimum of five samples per month was needed to get a reliable average radioactivity at each station (*7*).

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(*6*) INSTITUTO NACIONAL DE ENERGIA NUCLEAR. Mexican air monitoring program, August-December 1970 and January 1971. Radiol Health Data Rep 12:525-528 (October 1971).

(*7*) VASQUEZ, M. and R. M. DE NULMAN. Estudios sobre la radioactividad ambiental en la Republica Mexicana, 1963-1965. Comision Nacional de Energia Nuclear, Direccion General de Seguridad Radiologica (1966).

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Air Surveillance Network, May 1970

National Environmental Research Center—
Las Vegas,[1] Environmental Protection Agency

The Air Surveillance Network[2] (ASN), operated by the National Environmental Research Center—Las Vegas (NERC–LV), consists of 104 active and 18 standby sampling stations located in 21 western States (figures 1 and 2). The network is operated in support of nuclear testing sponsored by the Atomic Energy Commission (AEC) at the Nevada Test Site (NTS), by the Space Nuclear Systems Office at the Nuclear Rocket Development Station which lies within the NTS, and by the AEC at any other designated testing sites.

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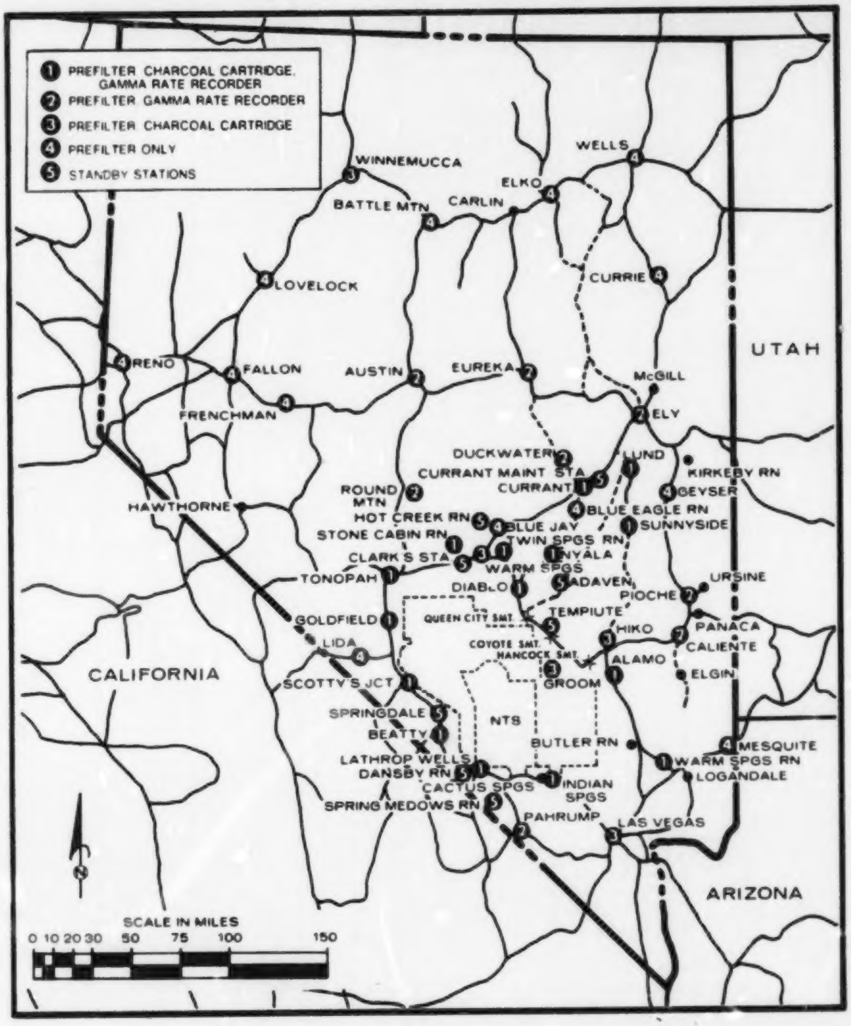
[1] Formerly the Western Environmental Research Laboratory.

[2] The ASN is operated under a Memorandum of Understanding (No. AT(26–1)–539) with the Nevada Operations Offict, U.S. Atomic Energy Commission.



① PREFILTER CHARCOAL CARTRIDGE, GAMMA RATE RECORDER
② PREFILTER GAMMA RATE RECORDER
③ PREFILTER CHARCOAL CARTRIDGE
④ PREFILTER ONLY
⑤ STANDBY STATIONS
WINNEMUCCA
WELLS
ELKO
BATTLE MTN
CARLIN
LOVELOCK
CURRIE
UTAH
RENO
FALLON
AUSTIN
EUREKA
McGILL
FRENCHMAN
ELY
DUCKWATER
LUND
KIRKEBY RN
CURRANT MAINT STA
CURRANT
GEYSER
ROUND MTN
HAWTHORNE
HOT CREEK RN
BLUE EAGLE RN
BLUE JAY
SUNNYSIDE
STONE CABIN RN
TWIN SPGS RN
NYALA
CLARK'S STA
WARM SPGS
TONOPAH
DIABLO
ADAVEN
URSINE
PIOCHE
GOLDFIELD
QUEEN CITY SMT
TEMPIUTE
PANACA
HIKO
CALIENTE
COYOTE SMT
HANCOCK SMT
LIDA
ALAMO
ELGIN
CALIFORNIA
SCOTTY'S JCT
GROOM
SPRINGDALE
NTS
BEATTY
BUTLER RN
MESQUITE
LATHROP WELLS
WARM SPGS RN
DANSBY RN
LOGANDALE
CACTUS SPGS
INDIAN SPGS
SPRING MEDOWS RN
PAHRUMP
LAS VEGAS
N
ARIZONA
SCALE IN MILES
0 10 20 30 50 75 100 150

Figure 1. NERC–LV Air Surveillance Network stations in Nevada

Table 1. Summary of gross beta radioactivity concentrations in air, May 1972

Location		Number of samples	Concentration (pCi/m³)		
			Maximum	Minimum	Average[a]
Ariz:	Phoenix	29	1.1	<0.1	0.6
	Seligman	31	1.0	.2	.6
	Winslow	31	1.3	.3	.6
Ark:	Little Rock	21	.6	<.1	.3
Calif:	Baker	27	.7	.1	.4
	Barstow	31	1.2	.2	.5
	Bishop	31	1.1	<.1	.6
	Death Valley Junction	30	1.0	.2	.5
	Furnace Creek	29	1.1	.2	.6
	Indio	31	.9	<.1	.4
	Lone Pine	29	1.0	<.1	.5
	Needles	24	1.3	.3	.6
	Ridgecrest	30	1.2	.1	.5
	Shoshone	31	1.1	.2	.5
Colo:	Denver	23	.9	.2	.5
	Durango	31	1.3	.2	.5
Idaho:	Boise	30	1.1	<.1	.5
	Idaho Falls	23	.9	.2	.4
	Preston	30	.7	<.1	.4
	Twin Falls	31	.9	<.1	.5
Iowa:	Iowa City	22	.7	.1	.3
	Sioux City	27	.9	<.1	.4
Kans:	Dodge City	31	.9	<.1	.3
La:	Lake Charles	22	.5	<.1	.4
	Monroe	21	.6	.1	.4
	New Orleans	21	.5	<.1	.3
Minn:	Minneapolis	20	.7	.1	.3
Mo:	Joplin	31	.8	<.1	.3
	St. Joseph	31	.7	<.1	.4
	St. Louis	30	.9	<.1	.4
Nebr:	North Platte	13	.4	.1	.3
Nev:	Alamo	31	1.3	.2	.5
	Austin	19	.9	.2	.5
	Battle Mountain	31	1.1	.1	.5
	Beatty	31	1.0	.3	.5
	Blue Eagle Ranch (Currant)	28	1.5	.3	.6
	Blue Jay	31	1.0	.2	.5
	Caliente	31	1.0	.2	.5
	Currant Ranch	31	1.3	.3	.6
	Currie	31	.8	<.1	.5
	Diablo	31	.8	.2	.5
	Duckwater	24	1.0	<.1	.5
	Elko	31	.9	.1	.5
	Ely	30	.9	<.1	.5
	Eureka	31	.8	.2	.5
	Fallini's Twin Springs Ranch	31	.9	.2	.5
	Fallon	31	1.9	.1	.6
	Frenchman Station	31	.8	<.1	.5
	Geyser Maintenance Station	31	1.0	<.1	.6
	Goldfield	30	1.5	.3	.6
	Groom Lake	29	1.1	.2	.5
	Hiko	31	1.2	.1	.5
	Indian Springs	31	.8	.1	.4
	Las Vegas	22	1.0	.2	.6
	Lathrop Wells	27	.9	.3	.5
	Lida	31	1.8	.2	.6
	Lovelock	31	1.0	.1	.5
	Lund	27	.8	.2	.5
	Mesquite	31	1.0	.3	.5
	Nyala	31	1.5	<.1	.6
	Pahrump	23	1.1	.2	.4
	Pioche	31	1.0	.1	.5
	Reno	30	.9	<.1	.5
	Round Mountain	30	.7	<.1	.5
	Scotty's Junction	29	1.0	.3	.5
	Stone Cabin Ranch	31	1.0	.2	.5
	Sunnyside	29	1.4	.1	.6
	Tonopah	31	1.1	.2	.5
	Tonopah Test Range	26	.8	.2	.4
	Warm Springs Ranch	31	1.3	.2	.5
	Wells	31	1.1	<.1	.5
	Winnemucca	31	1.1	<.1	.5
N. Mex:	Albuquerque	22	1.1	.2	.5
	Carlsbad	27	1.0	<.1	.5
Okla:	Muskogee	31	.7	<.1	.3
Oreg:	Burns	31	1.1	.1	.4
	Medford	25	.7	<.1	.3
S. Dak:	Aberdeen	30	.9	<.1	.3
	Rapid City	29	1.1	<.1	.3
Tex:	Abilene	28	1.3	.1	.5
	Amarillo	30	.9	.1	.4
	Austin	22	1.1	.2	.4
	Fort Worth	31	.8	<.1	.4

See footnotes at end of table.

Table 1. Summary of gross beta radioactivity concentrations in air, May 1972 —continued

Location		Number of samples	Concentration (pCi/m^3)		
			Maximum	Minimum	Average[a]
Utah:	Bryce Canyon	21	.6	.2	.5
	Cedar City	30	1.0	.1	.6
	Delta	30	.9	<.1	.5
	Dugway	31	1.1	.1	.5
	Enterprise	31	.8	.2	.5
	Garrison	31	.9	<.1	.4
	Logan	31	.8	<.1	.4
	Milford	30	.9	.2	.5
	Monticello	30	1.3	<.1	.6
	Parowan	19	1.2	<.1	.5
	Provo	29	1.1	.2	.6
	Roosevelt	29	.9	<.1	.4
	Salt Lake City	31	1.0	.1	.5
	St. George	31	1.4	.3	.6
	Wendover	30	1.0	.1	.6
Wash:	Seattle	22	.4	<.1	.2
	Spokane	22	.4	<.1	.2
Wyo:	Rock Springs	31	.7	.1	.4
	Worland	31	.5	<.1	.3

[a] Individual values less than the minimum detectable concentration (MDC) are set equal to the MDC for averaging. A monthly average less than the minimum reportable value of 0.1 pCi/m^3 is reported as <0.1.

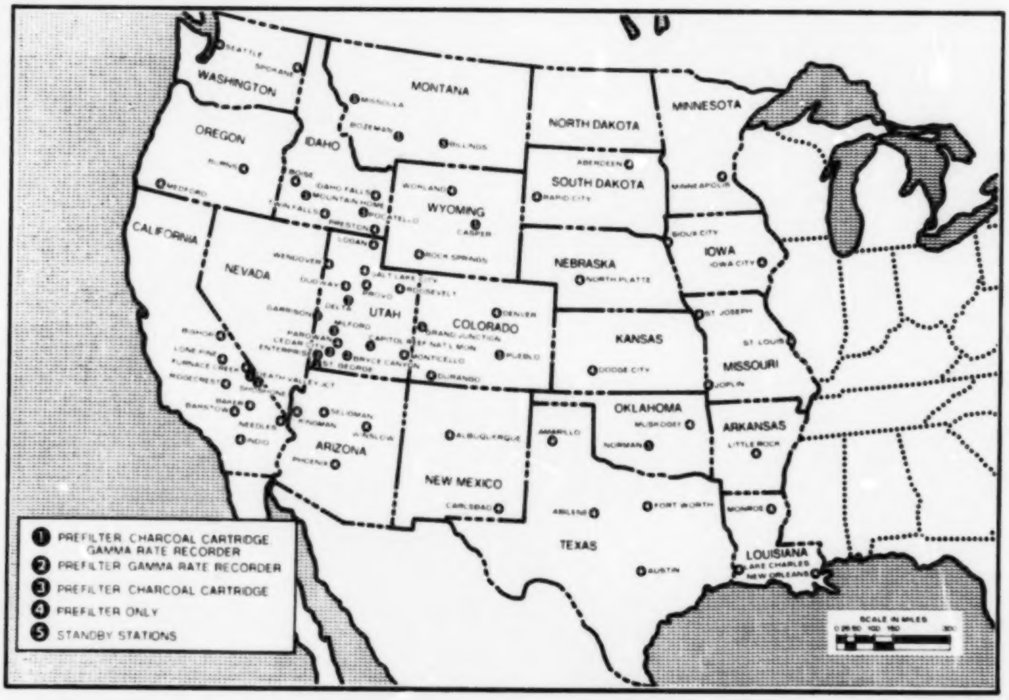

WASHINGTON
SEATTLE
SPOKANE
OREGON
BURNS
MEDFORD
IDAHO
BOISE
IDAHO FALLS
MOUNTAIN HOME
TWIN FALLS
POCATELLO
PRESTON
MONTANA
MISSOULA
BOZEMAN
BILLINGS
WYOMING
WORLAND
CASPER
ROCK SPRINGS
CALIFORNIA
BISHOP
LONE PINE
FURNACE CREEK
RIDGECREST
BAKER
BARSTOW
NEEDLES
INDIO
NEVADA
DEATH VALLEY JCT
SHOSHONE
UTAH
LOGAN
WENDOVER
SALT LAKE CITY
DUGWAY
PROVO
ROOSEVELT
DELTA
GARRISON
MILFORD
PAROWAN
CEDAR CITY
ENTERPRISE
CAPITOL REEF NAT'L MON
BRYCE CANYON
ST GEORGE
MONTICELLO
COLORADO
DENVER
GRAND JUNCTION
PUEBLO
DURANGO
ARIZONA
KINGMAN
SELIGMAN
WINSLOW
PHOENIX
NEW MEXICO
ALBUQUERQUE
CARLSBAD
NORTH DAKOTA
SOUTH DAKOTA
ABERDEEN
RAPID CITY
NEBRASKA
NORTH PLATTE
KANSAS
DODGE CITY
OKLAHOMA
MUSKOGEE
NORMAN
TEXAS
AMARILLO
ABILENE
FORT WORTH
AUSTIN
MINNESOTA
MINNEAPOLIS
IOWA
SIOUX CITY
IOWA CITY
MISSOURI
ST JOSEPH
ST LOUIS
JOPLIN
ARKANSAS
LITTLE ROCK
LOUISIANA
MONROE
LAKE CHARLES
NEW ORLEANS
SCALE IN MILES
0 25 50 100 150 300
❶ PREFILTER CHARCOAL CARTRIDGE GAMMA RATE RECORDER
❷ PREFILTER GAMMA RATE RECORDER
❸ PREFILTER CHARCOAL CARTRIDGE
❹ PREFILTER ONLY
❺ STANDBY STATIONS

Figure 2. NERC–LV Air Surveillance Network stations outside Nevada

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The stations are operated by State health department personnel and by private individuals on a contract basis. Daily 24-hour samples are collected at each station. All samples are mailed to the NERC–LV unless special retrieval is arranged at selected locations in support of known releases of radioactivity from the NTS. A complete description of sampling and analytical procedures was presented in the February 1972 issue of *Radiation Data and Reports.*

Results

Table 1 presents the monthly average gross beta radioactivity in air particulates for each of the network stations. The minimum reported concentration for gross beta is 0.1 pCi/m^3; however, gross beta concentrations above the minimum detectable concentration of 0.06 pCi/m^3 are used in determining averages. Individual concentrations which are below the minimum detectable concentration are assumed to be equal to the minimum detectable concentration. Averages less than the minimum reported level are reported as <0.1 pCi/m^3. The highest gross beta concentration within the network on a single filter during May was 1.9 pCi/m^3 at Fallon, Nev.

From gamma spectrometry results, cerium-141, ruthenium-103, and zirconium-95 in varying combinations were identified on samples collected in Arizona, California, Nevada, New Mexico, Texas, and Utah. The highest concentrations of these radionuclides, respectively, were 0.2 pCi/m^3 at Barstow, Calif.; 0.1 pCi/m^3 at Caliente and Las Vegas, Nev.; and 0.8 pCi/m^3 at Groom Lake, Nev. These radionuclides are attributed to annual worldwide fallout.

Copies of this summary and listings of the daily gross beta and gamma spectrometry results are distributed to EPA regional offices and appropriate State agencies. Additional copies of the daily results may be obtained from the NERC–LV upon written request.

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SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are such data as those obtained from human bone sampling, Alaskan surveillance, and environmental monitoring around nuclear facilities.

Offsite Surveillance Around the Nevada Test Site January–June 1969[1]

National Environmental Research Center—
Las Vegas, EPA,[2] and
Nevada Operations Office, AEC

Under a Memorandum of Understanding with the U.S. Atomic Energy Commission, the Southwestern Radiological Health Laboratory (SWRHL) conducted its continuing program of radiological surveillance, including monitoring and environmental sampling, in the public areas surrounding the Nevada Test Site (NTS) from January through June 1969. During this period, 11 announced underground nuclear tests were conducted at the NTS. None of these tests released radioactivity that was detected offsite. One Experimental Plan (test) of the XE-Prime reactor test series was conducted at the Nuclear Rocket Development Station (NRDS), a part of the NTS complex, and released radioactive effluent that was detected offsite. Additional amounts of radioactivity found on air samples during this period are attributed to Project Schooner, a cratering experiment conducted in December 1968.

Operational procedures

Comprehensive ground monitoring capabilities were maintained throughout the period. Mobile ground monitoring teams were positioned in offsite areas prior to each event. Each monitor was equipped with an Eberline E–500B survey meter, a Baird-Atomic Model NE–148A Scintillator, and a Victoreen Radector, Model No. AGB–50B–Sr. Eberline RM–11 gamma-rate recorders were also used to document cloud passage at fixed ground locations. Aerial monitoring capabilities included a USAF aircraft carrying two SWRHL monitors equipped with portable instruments identical to those of the ground monitoring teams. Immediately after the release of radioactivity this aerial monitoring team tracked the cloud, determined its relative radiation intensity and reported its position, speed and direction to assist in positioning ground monitors. Two SWRHL aircraft also aided in cloud tracking and performed cloud sampling as required.

The SWRHL Air Surveillance Network (ASN) consisted of 103 stations operating in every State west of the Mississippi River except Montana and North Dakota (figure 1). The air sampler used was a Gelman "Tempest" which was equipped to use a 4-inch-diameter Whatman 541 filter paper and an MSA charcoal cartridge.

In addition to air sampling, milk, water and vegetation samples were collected and analyzed. The routine milk sampling program was continued through this period, collecting a total of 215 samples from both commercial dairies and private producers. Five hundred and thirty-two water samples, including 36 samples taken for Project Rulison background information, were collected from 95 sources of both potable and

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[1] This article is a summary of report No. SWRHL–97r, "Offsite Surveillance Activities of the Southwestern Radiological Health Laboratory from January through June 1969."

[2] Formerly the Southwestern Radiological Health Laboratory, U.S. Department of Health, Education, and Welfare, Public Health Service, Bureau of Radiological Health.

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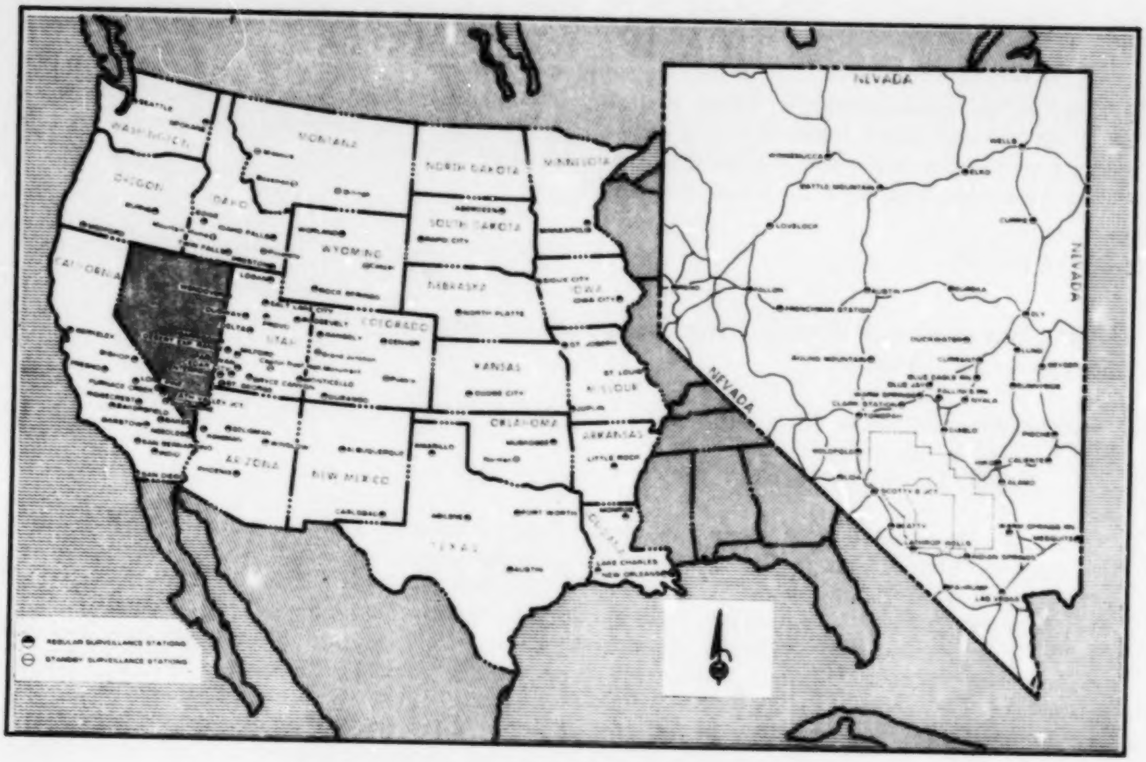
WASHINGTON
OREGON
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NORTH DAKOTA
MINNESOTA
SOUTH DAKOTA
WYOMING
NEBRASKA
IOWA
UTAH
COLORADO
KANSAS
MISSOURI
OKLAHOMA
ARKANSAS
ARIZONA
NEW MEXICO
TEXAS
LOUISIANA
NEVADA
REGULAR SURVEILLANCE STATIONS
STANDBY SURVEILLANCE STATIONS

Figure 1. NERC–LV Air Surveillance Network stations

nonpotable supplies. Vegetation samples, collected to delineate any fallout pattern, consisted of milk cow feed samples taken at most locations where milk was collected.

Approximately 87 residents in the offsite area were issued film badge dosimeters during this period and five film badges were placed at each of 107 dosimetry stations. The DuPont type 545 film in the badge has a 30 mR lower limit of detection. All stations were also equipped with three EG&G TL–12 thermoluminescent dosimeters (TLD's) which have a 5 mR lower limit of detection.

A SWRHL medical officer was available to investigate reports of injuries alleged to be the result of the test series and to maintain liaison with local physicians. No injuries were reported. Veterinarian services were also provided by the SWRHL to conduct wildlife and domestic livestock investigations. Other community relations services included personal contact with offsite residents by route monitors and through numerous information presentations conducted at schools and civic centers. As a result, many offsite residents participated in the sampling program. All routine air sampling stations except Las Vegas stations were operated by local citizens.

Analytical procedures

All samples were analyzed at the SWRHL in Las Vegas. Air sample particulate filters were counted for beta radioactivity in a Beckman Widebeta low background, proportional counter system. Selected particulate filters, all charcoal cartridges, and water and milk samples were analyzed for gamma-emitting isotopes; a 4- by 4-inch NaI(Tl) crystal coupled to a TMC gamma pulse height analyzer was used. The lower limit of detection for gamma emitters in milk samples was 20 pCi/liter at the time of count. Gamma spectra were evaluated using a matrix technique which allowed for the determination of eight nuclides simultaneously.

Results

The only release of radioactive material detected offsite during this period resulted from a power run of the XE-Prime nuclear rocket engine on June 11. Radioactive material, primarily tungsten-181, was also found early in the year and attributable to resuspension of radioactive debris deposited on- and offsite after the Schooner test on December 8, 1968.

The singular indication at ground level of radioactivity released by XE-Prime was from an air sample collected at the Diablo Maintenance Station on Highway 25, Nevada. The gross beta particulate concentration from 0645 hours, June 11 through 0645 hours, June 12 was 2.4 pCi/m^3. A total of 0.7 pCi/m^3 of iodine-131 was determined from the filter and charcoal cartridge.

No fresh fission products were found in any milk, water, or vegetation samples and no readings above background were recorded by exposure rate instruments or dosimetry media.

Small concentrations of tungsten-181, attributable to Project Schooner, were occasionally found on air sample filters to the north-northwest of the NTS through March 1969. The highest concentration was found at Clark Station on January 13 and measured 55 pCi/m^3 gross beta.

Conclusions

Results obtained through environmental radiation surveillance during this period indicate that no individual in the offsite area received an exposure, resulting from NTS operations, which exceeded the guides established by the AEC and/or recommended by the Federal Radiation Council.

Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission (AEC) receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the "AEC Manual."[1]

A summary of the environmental radioactivity data follow for the Brookhaven National Laboratory and Neutron Devices Department.

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[1] Title 10, Code to Federal Regulations, Part 20, "Standards for Protection Against Radiation" contains essentially the standards published in Chapter 0524 of the AEC Manual.

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1. Brookhaven National Laboratory[2] July–December 1969

Associated Universities, Inc.
Upton, N.Y.

The Brookhaven National Laboratory (BNL) operations may affect the environmental levels of radiation in three ways: (1) by radioactivity in the cooling air from the research reactors, (2) by radiation from an ecology forest gamma-ray source, and (3) by low-level radioactive liquid wastes released to a stream that forms one of the headwaters of the Peconic River (figure 1). The radiation levels resulting from reactor air effluent and the ecology forest source are monitored continuously by four stations located at the site boundary. The liquid waste effluent from the laboratory sewage processing plant is monitored continuously at the point where the stream leaves the site.

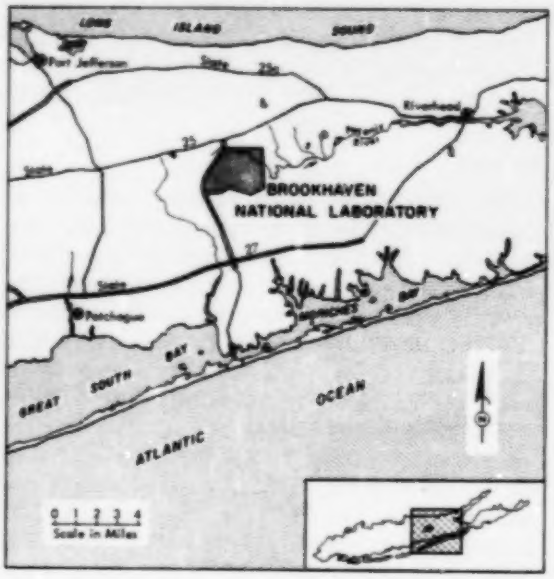

Figure 1. Brookhaven National Laboratory and surrounding area

Table 1. External gamma radioactivity at BNL site perimenter due to laboratory operations,[a] July–December 1969

1969	Average exposure tares (mR/week)			
	Northwest perimeter	Southwest perimeter	Southeast perimeter	Northeast perimeter
July	0.00	0.00	0.00	2.01
August	.00	.00	.00	2.08
September	.00	.00	.00	1.89
October	.00	.00	.00	1.63
November	.00	.00	.00	1.57
December	.00	.00	.00	1.31
Highest weekly reading (July-December)	0.00	0.00	0.00	2.17
Average undisturbed background (July-December)	1.67	1.88	1.82	1.72
1969 summary:				
January-June	.008	0.00	0.08	1.51
July-December	.00	.00	.00	1.74
January-December	.04	.06	.04	1.63
Highest weekly reading, 1969	1.38	.04	.76	2.44
Average undisturbed background (January-December)	1.65	1.75	1.75	1.62

[a] Due principally to argon-41 in reactor cooling air, and at the northeast perimeter, to the ecology forest cesium-137 source.

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[2] Summarized from "Effects of Brookhaven National Laboratory on Environmental Levels of Radioactivity during the Second Half of 1969," Associated Universities, Inc., Upton, N.Y. 11973.

Area monitoring

The average weekly radiation levels at the Brookhaven National Laboratory site perimeter (figure 2), due to laboratory operations, are given in table 1. Radiation levels at the northeast perimeter are somewhat greater than at other monitoring stations due to a cesium-137 source located in the nearby forest. The radiation levels at this location were 17 percent of the established Atomic Energy Commission (AEC) radiation protection standard of 500 mrem/a for individuals in the general population. Values of radiation background levels undisturbed by laboratory operations also have been included in table 1 for purposes of comparison.

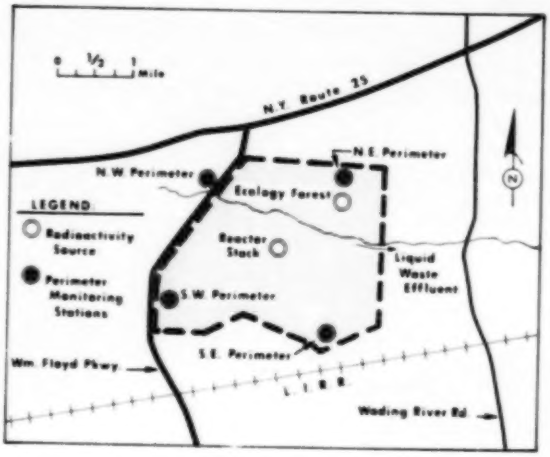

Figure 2. Brookhaven National Laboratory monitoring station locations

Water monitoring

The liquid waste effluent from the laboratory sewage processing plant is monitored continuously at the point where the stream leaves the BNL site. The average concentration and total amount of gross beta radioactivity in the liquid waste effluent, at the site boundary, are shown in table 2 for July-December 1969.

Analysis of composite samples of the effluent has shown that, on the average, less than 20 percent of the radioactivity consists of strontium-90. No appreciable amounts of radioactive iodine or bone-seeking radionuclides (such as radium) other than strontium, are present. Under these conditions, the applicable AEC radiation protection standard for discharge of liquid waste to uncontrolled areas would be 1 nCi/liter.

Most gross beta measurement instruments are not sensitive to low energy beta emitters, such as tritium, for which special analytical methods must be employed. The concentration and amounts of tritium found during this reporting period in the laboratory's liquid waste effluent are also shown in table 2. The applicable AEC standard is 3 μCi/liter, averaged over a period of 1 year. The observed concentration of tritium at BNL was 0.4 percent of this standard.

Recent coverage in *Radiation Data and Reports:*

Period	Issue
January–June 1969	August 1972

Table 2. Gross beta radioactivity in liquid waste effluent at BNL site boundary, July–December 1969.

1969	Volume of flow (gallons/day)	Average beta radioactivity concentration (pCi/liter)	Total beta radioactivity concentration discharged (mCi)	Tritium concentration (nCi/liter)	Tritium radioactivity (Ci)
July	204,000	13	0.3	16	0.4
August	590,000	10	.8	7	.6
September	395,000	10	.4	2	.1
October	395,000	9	.4	34	1.4
November	465,000	15	1.0	14	.8
December	788,000	11	.8	6	.5
January-June	551,000	16	6.2	3	1.7
July-December	480,000	11	3.7	11	3.7
January-December	515,000	14	9.9	8	5.4

2. Neutron Devices Department[3]
January–June 1971

General Electric Company
St. Petersburg, Fla.

The Neutron Devices Department (figure 3) is an electronic component production facility. The plant maintains an environmental monitoring program to measure the levels of radioactive environmental contamination associated with plant effluents. These measurements serve as an index of the effectiveness of the plant's contamination control measures. Sewer effluent, surface water, milk, and air within 6 miles of the plant are monitored for radioactivity. The radioactivity concentrations, weighted by atmospheric and stream dilution factors, are compared with the AEC standards for continuous nonoccupational exposure as presented in AEC Manual chapter 0524.

Sewer effluent monitoring

Waste water discharges from the plant were sampled routinely at the site's boundary and analyzed for radioactive material. A total of 126 samples were obtained and analyzed for tritium content. In those instances where detectable concentrations occurred, the radioactivity resulted from controlled releases. Radioactivity releases from the process waste system into the plant's water effluents resulted in an average tritium concentration for the period of less than 4 percent of the AEC standard for continuous nonoccupational exposure (3 μCi/liter).

Surface water sampling

There were no indications of tritium in 159 routine surface water samples collected from areas surrounding the plant (detectable level—

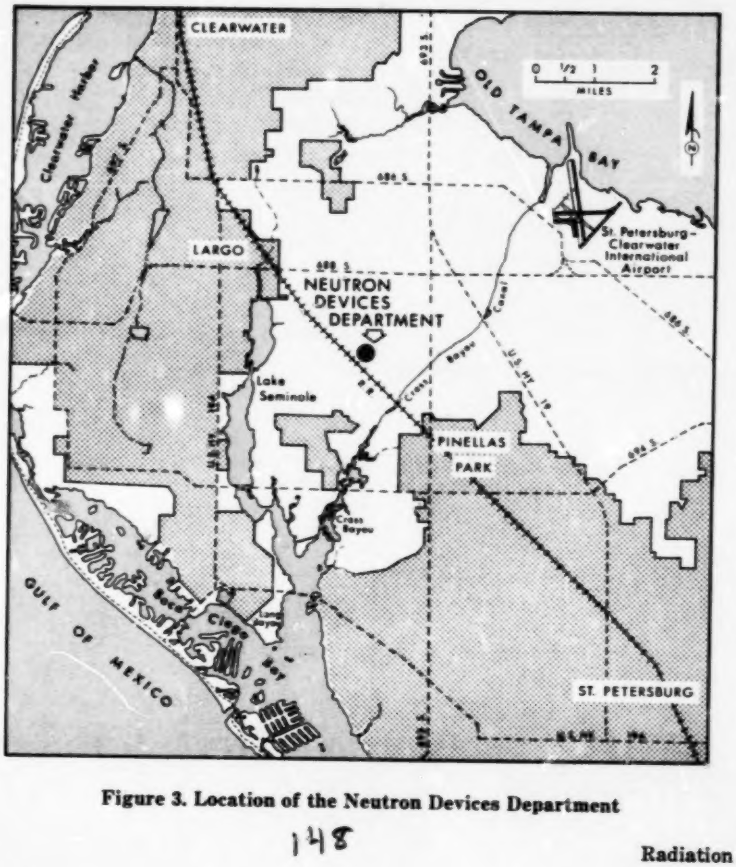
CLEARWATER
Clearwater Harbor
OLD TAMPA BAY
0 1/2 1 2
MILES
N
St. Petersburg-Clearwater International Airport
LARGO
NEUTRON DEVICES DEPARTMENT
Lake Seminole
Cross Bayou Canal
U.S. HY 19
PINELLAS PARK
Cross Bayou
GULF OF MEXICO
Boca Ciega Bay
ST. PETERSBURG

Figure 3. Location of the Neutron Devices Department

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[3] Summarized from "Environmental Monitoring, January 1 through June 30, 1971." General Electric Company, Neutron Devices Department, St. Petersburg, Fla.

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40 nCi/liter). These sample locations represent an area up to 6 miles in all directions from the plant site and are not related to the waste water effluent from the plant.

Milk sampling results

Analyses of 10 raw milk samples, provided by the Pinellas County Health Department from the one local dairy farm, revealed no detectable concentrations (detectable level—40 nCi/liter) of tritium.

Air sampling results

A total of 7 air samples were obtained during times of radioactivity releases. Analyses of these samples revealed that the maximum concentration, occurring over a period of 30 minutes, represented less than 0.6 percent of the AEC standard for tritium oxide in air for continuous nonoccupational exposure (200 nCi/liter).

Summary

Offsite radioactivity concentrations encountered by the general population are substantially lower than the AEC standards for continuous nonoccupational exposure.

Recent coverage in *Radiation Data and Reports*:

Period	Issue
January–June 1970	February 1971
July–December 1970	April 1972

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Nuclear Power Reactors in the United States
June 30, 1972

Each quarter year, the Atomic Energy Commission releases information on the status of all present and proposed civilian nuclear power generating units in the United States. This information is reproduced for interested readers of *Radiation Data and Reports.*

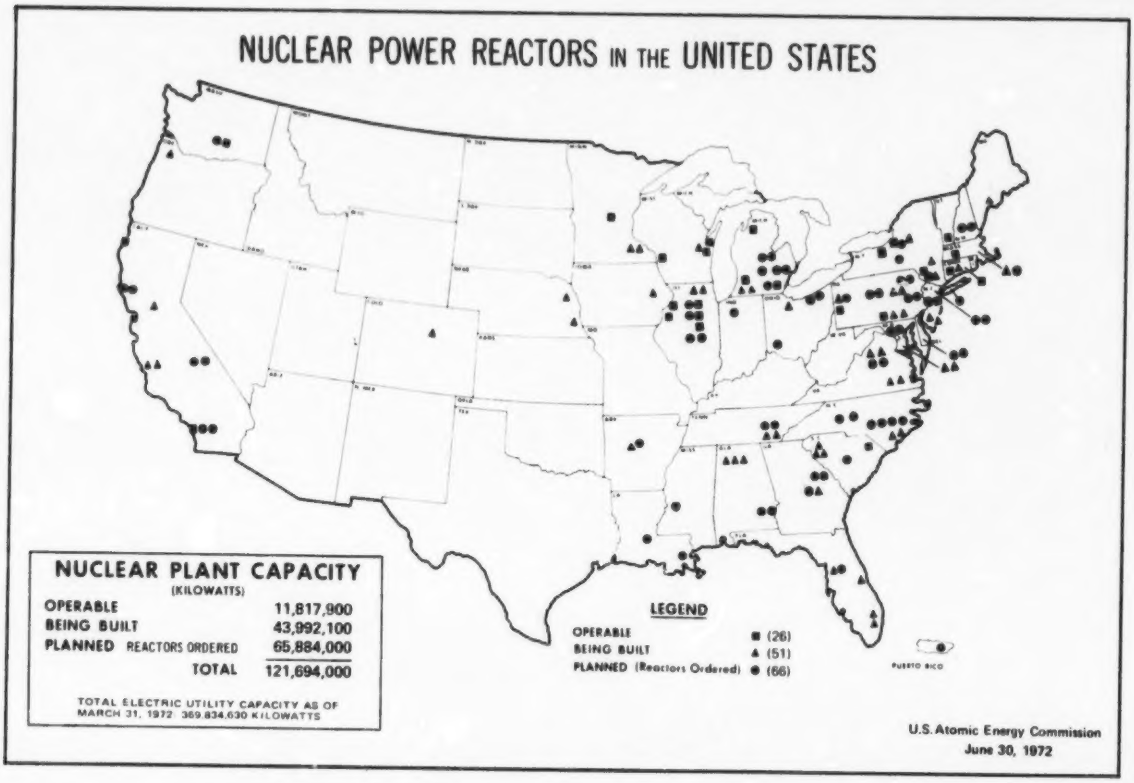
NUCLEAR POWER REACTORS IN THE UNITED STATES
NUCLEAR PLANT CAPACITY
(KILOWATTS)
OPERABLE 11,817,900
BEING BUILT 43,992,100
PLANNED REACTORS ORDERED 65,884,000
TOTAL 121,694,000
TOTAL ELECTRIC UTILITY CAPACITY AS OF MARCH 31, 1972: 369,834,630 KILOWATTS
LEGEND
OPERABLE ■ (26)
BEING BUILT ▲ (51)
PLANNED (Reactors Ordered) ● (66)
PUERTO RICO
U.S. Atomic Energy Commission
June 30, 1972

Figure 1. Nuclear power plants in the United States

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SITE	PLANT NAME	CAPACITY (Net Kilowatts)	UTILITY	INITIAL DESIGN POWER
ALABAMA				
Decatur	Browns Ferry Nuclear Power Plant: Unit 1	1,065,000	Tennessee Valley Authority	1972
Decatur	Browns Ferry Nuclear Power Plant: Unit 2	1,065,000	Tennessee Valley Authority	1973
Decatur	Browns Ferry Nuclear Power Plant: Unit 3	1,065,000	Tennessee Valley Authority	1973
Dothan	Joseph M. Farley Nuclear Plant: Unit 1	829,000	Alabama Power Co.	1975
Dothan	Joseph M. Farley Nuclear Plant: Unit 2	829,000	Alabama Power Co.	1977
ARKANSAS				
Russellville	Arkansas Nuclear One: Unit 1	820,000	Arkansas Power & Light Co.	1973
Russellville	Arkansas Nuclear One: Unit 2	920,000	Arkansas Power & Light Co.	1975
CALIFORNIA				
Humboldt Bay	Humboldt Bay Power Plant: Unit 3	68,500	Pacific Gas and Electric Co.	1963
San Clemente	San Onofre Nuclear Generating Station: Unit 1	430,000	So. Calif. Ed. & San Diego Gas & El. Co.	1967
San Clemente	San Onofre Nuclear Generating Station: Unit 2	1,140,000	So. Calif. Ed. & San Diego Gas & El. Co.	–
San Clemente	San Onofre Nuclear Generating Station: Unit 3	1,140,000	So. Calif. Ed. & San Diego Gas & El. Co.	–
Diablo Canyon	Diablo Canyon Nuclear Power Plant: Unit 1	1,060,000	Pacific Gas and Electric Co.	1974
Diablo Canyon	Diablo Canyon Nuclear Power Plant: Unit 2	1,060,000	Pacific Gas and Electric Co.	1975
Clay Station	Rancho Seco Nuclear Generating Station	804,000	Sacramento Municipal Utility District	1973
Pt. Arena	Mendocino Power Plant: Unit 1	1,128,000	Pacific Gas & Electric Co.	1978
Pt. Arena	Mendocino Power Plant: Unit 2	1,128,000	Pacific Gas & Electric Co.	1979
•	–	770,000	Southern California Edison Co.	1981
•	–	770,000	Southern California Edison Co.	1982
COLORADO				
Platteville	Ft. St. Vrain Nuclear Generating Station	330,000	Public Service Co. of Colorado	1972
CONNECTICUT				
Haddam Neck	Haddam Neck Plant	575,000	Conn. Yankee Atomic Power Co.	1967
Waterford	Millstone Nuclear Power Station: Unit 1	652,100	Northeast Utilities	1970
Waterford	Millstone Nuclear Power Station: Unit 2	828,000	Northeast Utilities	1974
DELAWARE				
•	Delmarva Unit 1	770,000	Delmarva Power & Light Co.	1978
•	Delmarva Unit 2	770,000	Delmarva Power & Light Co.	1982
FLORIDA				
Turkey Point	Turkey Point Station: Unit 3	693,000	Florida Power & Light Co.	1972
Turkey Point	Turkey Point Station: Unit 4	693,000	Florida Power & Light Co.	1972
Red Level	Crystal River Plant: Unit 3	825,000	Florida Power Corp.	1973
Red Level	Crystal River Plant: Unit 4	897,000	Florida Power Corp.	1978
Ft. Pierce	Hutchinson Island: Unit 1	800,000	Florida Power and Light Co.	1974
GEORGIA				
Baxley	Edwin I. Hatch Nuclear Plant: Unit 1	786,000	Georgia Power Co.	1973
Baxley	Edwin I. Hatch Nuclear Plant: Unit 2	786,000	Georgia Power Co.	1976
Waynesboro	Alvin W. Vogtle, Jr. Plant: Unit 1	1,100,000	Georgia Power Co.	1978
Waynesboro	Alvin W. Vogtle, Jr. Plant: Unit 2	1,100,000	Georgia Power Co.	1979
ILLINOIS				
Morris	Dresden Nuclear Power Station: Unit 1	200,000	Commonwealth Edison Co.	1960
Morris	Dresden Nuclear Power Station: Unit 2	800,000	Commonwealth Edison Co.	1970
Morris	Dresden Nuclear Power Station: Unit 3	800,000	Commonwealth Edison Co.	1972
Zion	Zion Nuclear Plant: Unit 1	1,050,000	Commonwealth Edison Co.	1972
Zion	Zion Nuclear Plant: Unit 2	1,050,000	Commonwealth Edison Co.	1973
Cordova	Quad-Cities Station: Unit 1	800,000	Comm. Ed. Co.-Ia.-Ill. Gas & Elec. Co.	1972
Cordova	Quad-Cities Station: Unit 2	800,000	Comm. Ed. Co.-Ia.-Ill. Gas & Elec. Co.	1972
Seneca	LaSalle Co. Nuclear Station: Unit 1	1,078,000	Comm. Ed. Co.-Ia.	1977
Seneca	LaSalle Co. Nuclear Station: Unit 2	1,078,000	Comm. Ed. Co.-Ia.	1978
•	Comed West: Unit 1	1,100,000	Comm. Edison Co.	1978
•	Comed West: Unit 2	1,100,000	Comm. Edison Co.	1979
INDIANA				
Dune Acres	Bailly Generating Station	660,000	Northern Indiana Public Service Co.	1977
IOWA				
Palo	Duane Arnold Energy Center: Unit 1	529,700	Iowa Electric Light and Power Co.	1973
LOUISIANA				
Taft	Waterford Generating Station	1,165,000	Louisiana Power & Light Co.	1976
St. Francisville	River Bend Station	940,000	Gulf States Utilities Co.	1979

Figure 1. Nuclear power plants in the United States—continued

SITE	PLANT NAME	CAPACITY (Net Kilowatts)	UTILITY	INITIAL DESIGN POWER
MAINE				
Wiscasset	Maine Yankee Atomic Power Plant	790,000	Maine Yankee Atomic Power Co.	1972
MARYLAND				
Lusby	Calvert Cliffs Nuclear Power Plant: Unit 1	845,000	Baltimore Gas and Electric Co.	1973
Lusby	Calvert Cliffs Nuclear Power Plant: Unit 2	845,000	Baltimore Gas and Electric Co.	1974
Perryman	Perryman Nuclear Plant: Unit 1	845,000	Baltimore Gas and Electric Co.	1979
Perryman	Perryman Nuclear Plant: Unit 2	845,000	Baltimore Gas and Electric Co.	1980
MASSACHUSETTS				
Rowe	Yankee Nuclear Power Station	175,000	Yankee Atomic Electric Co.	1961
Plymouth	Pilgrim Station: Unit 1	655,000	Boston Edison Co.	1972
Plymouth	Pilgrim Station: Unit 2	1,150,000	Boston Edison Co.	1978
MICHIGAN				
Big Rock Point	Big Rock Point Nuclear Plant	70,300	Consumers Power Co.	1963
South Haven	Palisades Nuclear Power Station	700,000	Consumers Power Co.	1971
Lagoona Beach	Enrico Fermi Atomic Power Plant: Unit 1	60,900	Detroit Edison Co.	1970
Lagoona Beach	Enrico Fermi Atomic Power Plant: Unit 2	1,123,000	Detroit Edison Co.	1975
Lagoona Beach	Enrico Fermi Atomic Power Plant: UNit 3	1,123,000	Detroit Edison Co.	1979
Bridgman	Donald C. Cook Plant: Unit 1	1,060,000	Indiana & Michigan Electric Co.	1973
Bridgman	Donald C. Cook Plant: Unit 2	1,060,000	Indiana & Michigan Electric Co.	1974
Midland	Midland Nuclear Power Plant: Unit 1	492,000	Consumers Power Co.	1977
Midland	Midland Nuclear Power Plant: Unit 2	818,000	Consumers Power Co.	1978
St. Clair County	Greenwood: Unit 2	1,150,000	Detroit Edison Co.	1979
St. Clair County	Greenwood: Unit 3	1,150,000	Detroit Edison Co.	1981
MINNESOTA				
Monticello	Monticello Nuclear Generating Plant	545,000	Northern States Power Co.	1971
Red Wing	Prairie Island Nuclear Generating Plant: Unit 1	530,000	Northern States Power Co.	1972
Red Wing	Prairie Island Nuclear Generating Plant: Unit 2	530,000	Northern States Power Co.	1974
MISSISSIPPI				
Port Gibson	Grand Gulf Nuclear Station	1,250,000	Mississippi Power & Light Co.	1979
NEBRASKA				
Fort Calhoun	Ft. Calhoun Station: Unit 1	457,400	Omaha Public Power District	1973
Brownville	Cooper Nuclear Station	778,000	Nebraska Public Power District and Iowa Power and Light Co.	1973
NEW HAMPSHIRE				
Seabrook	–	1,100,000	Public Service of N.H.	1979
Seabrook	–	1,100,000	Public Service of N.H.	1981
NEW JERSEY				
Toms River	Oyster Creek Nuclear Power Plant: Unit 1	640,000	Jersey Central Power & Light Co.	1969
Forked River	Forked River Generating Station: Unit 1	1,140,000	Jersey Central Power & Light Co.	1978
Salem	Salem Nuclear Generating Station: Unit 1	1,090,000	Public Service Electric and Gas, N.J.	1974
Salem	Salem Nuclear Generating Station: Unit 2	1,115,000	Public Service Electric and Gas, N.J.	1975
Bordentown	Newbold Nuclear Generating Station: Unit 1	1,067,000	Public Service Electric and Gas, N.J.	1978
Bordentown	Newbold Nuclear Generating Station: Unit 2	1,067,000	Public Service Electric and Gas, N.J.	1979
NEW YORK				
Indian Point	Indian Point Station: Unit 1	265,000	Consolidated Edison Co.	1963
Indian Point	Indian Point Station: Unit 2	873,000	Consolidated Edison Co.	1972
Indian Point	Indian Point Station: Unit 3	965,000	Consolidated Edison Co.	1974
Scriba	Nine Mile Point Nuclear Station: Unit 1	625,000	Niagara Mohawk Power Co.	1970
Scriba	Nine Mile Point Nuclear Station: Unit 2	1,080,000	Niagara Mohawk Power Co.	1978
Ontario	R. E. Ginna Nuclear Power Plant: Unit 1	420,000	Rochester Gas & Electric Co.	1970
Brookhaven	Shoreham Nuclear Power Station	819,000	Long Island Lighting Co.	1977
Lansing	Bell Station	838,000	New York State Electric & Gas. Co.	1978
Verplanck	Con. Ed. Nuclear #4	1,115,000	Consolidated Edison Co.	1977
Scriba	James A. Fitzpatrick Nuclear Power Plant	821,000	Power Authority of State of N.Y.	1973
NORTH CAROLINA				
Southport	Brunswick Steam Electric Plant: Unit 1	821,000	Carolina Power and Light Co.	1975
Southport	Brunswick Steam Electric Plant: Unit 2	821,000	Carolina Power and Light Co.	1974
Cowans Ford Dam	Wm. B. McGuire Nuclear Station: Unit 1	1,150,000	Duke Power Co.	1975
Cowans Ford Dam	Wm. B. McGuire Nuclear Station: Unit 2	1,150,000	Duke Power Co.	1977
Bonsal	Shearon Harris Plant: Unit 1	915,000	Carolina Power & Light Co.	1977
Bonsal	Shearon Harris Plant: Unit 2	915,000	Carolina Power & Light Co.	1978
Bonsal	Shearon Harris Plant: Unit 3	915,000	Carolina Power & Light Co.	1979
Bonsal	Shearon Harris Plant: Unit 4	915,000	Carolina Power & Light Co.	1980

Figure 1. Nuclear power plants in the United States—continued

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SITE	PLANT NAME	CAPACITY (Net Kilowatts)	UTILITY	INITIAL DESIGN POWER
OHIO				
Oak Harbor	Davis-Besse Nuclear Power Station	872,000	Toledo Edison-Cleveland Electric Illuminating Co.	1974
Painesville	Perry Nuclear Power Plant: Unit 1	1,100,000	Cleveland Electric Illuminating Co.	1979
Painesville	Perry Nuclear Power Plant: Unit 2	1,100,000	Cleveland Electric Illuminating Co.	1980
Moscow	Wm. H. Zimmer Nuclear Power Station: Unit 1	810,000	Cincinnati Gas & Electric Co.	1976
OREGON				
Prescott	Trojan Nuclear Plant: Unit 1	1,130,000	Portland General Electric Co.	1974
PENNSYLVANIA				
Peach Bottom	Peach Bottom Atomic Power Station: Unit 1	40,000	Philadelphia Electric Co.	1967
Peach Bottom	Peach Bottom Atomic Power Station: Unit 2	1,065,000	Philadelphia Electric Co.	1973
Peach Bottom	Peach Bottom Atomic Power Station: Unit 3	1,065,000	Philadelphia Electric Co.	1974
Pottstown	Limerick Generating Station: Unit 1	1,065,000	Philadelphia Electric Co.	1976
Pottstown	Limerick Generating Station: Unit 2	1,065,000	Philadelphia Electric Co.	1977
Shippingport	Shippingport Atomic Power Station: Unit 1	90,000	Duquesne Light Co.	1957
Shippingport	Beaver Valley Power Station: Unit 1	856,000	Duquesne Light Co.-Ohio Edison Co.	1974
Shippingport	Beaver Valley Power Station: Unit 2	856,000	Duquesne Light Co.-Ohio Edison Co.	1978
Goldsboro	Three Mile Island Nuclear Station: Unit 1	819,000	Metropolitan Edison Co.	1973
Goldsboro	Three Mile Island Nuclear Station: Unit 2	905,000	Jersey Central Power & Light Co.	1975
Berwick	Susquehanna Steam Electric Station: Unit 1	1,052,000	Pennsylvania Power and Light	1979
Berwick	Susquehanna Steam Electric Station: Unit 2	1,052,000	Pennsylvania Power and Light	1981
*	Philadelphia Electric Co.: HTGR No. 1	1,140,000	Philadelphia Electric Co.	1979
*	Philadelphia Electric Co.: HTGR No. 2	1,140,000	Philadelphia Electric Co.	1981
SOUTH CAROLINA				
Hartsville	H. B. Robinson S.E. Plant: Unit 2	700,000	Carolina Power & Light Co.	1971
Seneca	Oconee Nuclear Station: Unit 1	841,000	Duke Power Co.	1972
Seneca	Oconee Nuclear Station: Unit 2	886,000	Duke Power Co.	1973
Seneca	Oconee Nuclear Station: Unit 3	886,000	Duke Power Co.	1973
Broad River	Virgil C. Summer Nuclear Station: Unit 1	900,000	South Carolina Electric & Gas Co.	1977
TENNESSEE				
Daisy	Sequoyah Nuclear Power Plant: Unit 1	1,140,000	Tennessee Valley Authority	1974
Daisy	Sequoyah Nuclear Power Plant: Unit 2	1,140,000	Tennessee Valley Authority	1975
Spring City	Watts Bar Nuclear Plant: Unit 1	1,169,000	Tennessee Valley Authority	1976
Spring City	Watts Bar Nuclear Plant: Unit 2	1,169,000	Tennessee Valley Authority	1977
VERMONT				
Vernon	Vermont Yankee Generating Station	513,900	Vermont Yankee Nuclear Power Corp.	1972
VIRGINIA				
Gravel Neck	Surry Power Station: Unit 1	788,000	Virginia Electric & Power Co.	1972
Gravel Neck	Surry Power Station: Unit 2	788,000	Virginia Electric & Power Co.	1973
Mineral	North Anna Power Station: Unit 1	845,000	Virginia Electric & Power Co.	1974
Mineral	North Anna Power Station: Unit 2	845,000	Virginia Electric & Power Co.	1975
Mineral	North Anna Power Station: Unit 3	900,000	Virginia Electric & Power Co.	1977
Mineral	North Anna Power Station: Unit 4	900,000	Virginia Electric & Power Co.	1978
WASHINGTON				
Richland	N-Reactor/WPPSS Steam	800,000	Atomic Energy Commission	1966
Richland	Hanford No. 2	1,103,000	Washington Public Power Supply System	1977
WISCONSIN				
Genoa	Genoa Nuclear Generating Station	53,200	Dairyland Power Cooperative	1969
Two Creeks	Point Beach Nuclear Plant: Unit 1	497,000	Wisconsin Michigan Power Co.	1971
Two Creeks	Point Beach Nuclear Plant: Unit 2	497,000	Wisconsin Michigan Power Co.	1972
Carlton	Kewaunee Nuclear Power Plant: Unit 1	541,000	Wisconsin Michigan Power Co.	1972
PUERTO RICO				
Puerto De Jobos	Aguirre Nuclear Power Plant	583,000	Puerto Rico Water Resources Authority	1975

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* Site not selected.

*	–	1,175,000	Tennessee Valley Authority	1977
*	–	1,175,000	Tennessee Valley Authority	1978

Figure 1. Nuclear power plants in the United States—continued

Reported Nuclear Detonations, August 1972

(Includes seismic signals presumably from foreign nuclear detonations)

There were no United States nuclear detonations reported by the U.S. Atomic Energy Commission in August 1972.

The U.S. Atomic Energy Commission announced that the United States recorded seismic signals, presumably from a Soviet underground nuclear explosion. The signals originated from the Semipalatinsk nuclear test area and were equivalent to those of an underground nuclear explosion in the intermediate yield range of 20 to 200 kilotons.

On August 19, 1972, seismic signals, presumably from a Soviet underground nuclear explosion, were recorded by the United States. The signals originated north of the Caspian Sea and were equivalent to those of an underground nuclear explosion in the yield range of 20-200 kilotons.

Seismic signals presumably from a Soviet underground nuclear test with a yield range of 20-200 kilotons were recorded by the United States on August 25, 1972, about 11:45 p.m., EDT, at the Semipalatinsk nuclear test area.

Seismic signals from a Soviet underground nuclear test with a yield of about 1 megaton were recorded by the United States. The signals originated at approximately 2:00 a.m., EDT, August 28, 1972, at the Novaya Zemlya nuclear test area in the Arctic.

Information in this section is based on data received during the month, and is subject to change as additional information may become available. Persons requiring information for purposes of compiling announced nuclear detonation statistics are advised to contact the Division of Public Information, U.S. Atomic Energy Commission, Washington, D.C. 20545.

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☆U.S. GOVERNMENT PRINTING OFFICE: 1972 — 514-840/9

SYNOPSES

Synopses of reports, incorporating a list of key words, are furnished below in reference card format for the convenience of readers who may wish to clip them for their files.

ENVIRONMENTAL MONITORING AND DISPOSAL OF RADIOACTIVE WASTES FROM U.S. NAVAL NUCLEAR-POWERED SHIPS AND THEIR SUPPORT FACILITIES, 1971. ***M. E. Miles, G. L. Sjoblom, and R. D. Burke. Radiation Data and Reports, Vol. 13,*** **September 1972, pp. 469–478.**

This report assesses the effect on the environment of disposal of radioactive wastes originating from U.S. Naval nuclear propulsion plants and their support facilities. The total radioactivity discharged into all ports and harbors from the more than 100 reactor plants and supporting tenders, bases, and shipyards was less than 0.002 curie in 1971. This small amount of radioactivity has had no significant or discernable effect on the quality of the human environment. Results of environmental surveys of harbor water and bottom sediment for gross radioactivity and for cobalt-60 show that (1) no increase in radioactivity has been detected in harbor water, (2) discharges of liquid wastes from U.S. Naval nuclear-powered ships have not caused a measurable increase in the general background radioactivity of the environment, and (3) low-level cobalt-60 radioactivity is still detectable in localized areas of harbor bottom sediment around a few piers at operating bases and shipyards where maintenance and overhaul of Naval nuclear-powered ships have been conducted over a period of several years; these levels have decreased in recent years.

This report confirms that procedures used by the Navy to control discharges of radioactivity from U.S. Naval nuclear-powered ships and their support facilities are effective in protecting the environment and the health and safety of the general public.

KEYWORDS: Discharges, disposal, harbors, monitoring, nuclear-powered ships, radioactivity, U.S. Navy, wastes.

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